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National Science and Technology Development Plan

(2005 to 2008)

National Science Council, Executive Yuan

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

National Science and Technology Development Plan

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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
CGA	Coast Guard Administration
CPC	Consumer Protection Commission
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
DF	Development Fund
DGBAS	Directorate General of Budget, Accounting & Statistics
EPA	Environmental Protection Administration
FSC	Financial Supervisory Commission
MOEA	Ministry of Economic Affairs
MOE	Ministry of Education
MND	Ministry of National Defense
MOI	Ministry of the Interior
MOTC	Ministry of Transportation and Communications
NPM	National Palace Museum
NSC	National Science Council
PCC	Public Construction Commission
RDEC	Research, Development and Evaluation Commission
STAG	Science and Technology Advisory Group
TH	Taiwan Historica

Chapter 1 Introduction

The Executive Yuan held the Seventh National Science and Technology Conference in January 2005 as required by the Fundamental Science and Technology Act. This conference studied and discussed the country's current state of S&T development, its overall S&T development goals, strategies, and resources, the development goals, strategies, and resources of individual government agencies and in specific fields of science and technology, and other important matters bearing on the development of science and technology. This National Science and Technology Development Plan has been drafted on the basis of the National Science and Technology Conference's consensus positions and conclusions; it is intended to guide the formulation of S&T policies and the promotion of S&T research and development in Taiwan.

This Science and Technology Development Plan was jointly drafted on the basis of the summary report of the Seventh National Science and Technology Conference by the National Science Council, Academia Sinica, Executive Yuan Science and Technology Advisory Group, Ministry of the Interior, Ministry of National Defense, Ministry of Education, Ministry of Economic Affairs, Ministry of Transportation and Communications, Department of Health, Environmental Protection Administration, Atomic Energy Council, Council of Agriculture, Council of Labor Affairs, Public Construction Commission, National Palace Museum, Academia Historica, and Financial Supervisory Commission. The plan will serve as a blueprint for this country's S&T development policies over the next four years.

The Science and Technology Development Plan contains seven chapters: Chapter 1 is an introduction, Chapter 2 "Overall S&T Development Goals" lays out the six overall goals of strengthening the knowledge innovation system, creating industrial competitive advantages, enhancing citizens' quality of life, promoting sustainable development, raising citizens' S&T standards, and

strengthening the country's autonomous defense technology. Chapter 3 "National S&T Development Strategies" lays out the following six strategies and Chapter 4 lists key measures for implementing these strategies:

Strategy 1: Putting the S&T Policy System on a Sound Footing, Emphasizing the Effective Utilization of Resources

Strategy 2: Strengthening Manpower Planning and Utilization, Augmenting S&T Manpower

Strategy 3: Boosting Academic Research Standards, Developing Distinctive Academic Fields

Strategy 4: Encouraging Knowledge Innovation, Overcoming Industrial Development Barriers

Strategy 5: Fostering Everyday S&T Applications, Stimulating Interaction with Society

Strategy 6: Enhancing the Defense Technology System, Promoting Defensive Arms Development

Chapter 5 "S&T Development at Government Agencies" describes the S&T goals and strategies drafted by various agencies on the basis of S&T development strategies and visions, and the agencies' implementation via resource planning. Chapter 6 "S&T Projects in Various Fields of Science and Technology" explains how government S&T projects are classified under 37 fields in accordance with their characteristics for purposes of deliberation and planning. Chapter 7 "Implementation and Control" describes how the responsible agencies will draft implementation plans for the key measures of this plan, and carry out these plans as part of their annual administrative plans. The NSC must report to the Executive Yuan concerning the state of plan implementation on an annual basis.

This plan also provides detailed supplementary information in the form of appendices on the topics of current state of domestic S&T development and review, S&T development at government agencies, S&T projects in various

fields of science and technology, academic research, Challenge 2008: National Development Plan, national science and technology programs, and Program for Promoting Academic Excellence of Universities.

Chapter 2 Overall Goals

The following overall S&T development goals have been drawn up in view of the current state of S&T development in Taiwan and abroad and future trends:

Goal 1: Strengthening the knowledge innovation system.

Goal 2: Creating industrial competitive advantages.

Goal 3: Enhancing citizens' quality of life.

Goal 4: Promoting sustainable development.

Goal 5: Raising citizens' S&T standards.

Goal 6: Strengthening autonomous defense technology.

Chapter 3 Strategies

The following six strategies have been developed as means of achieving the foregoing goals:

Strategy 1: Putting the S&T policy system on a sound footing, emphasizing the effective utilization of resources.

Strategy 2: Strengthening manpower planning and utilization, augmenting S&T manpower.

Strategy 3: Boosting academic research standards, developing distinctive academic fields.

Strategy 4: Encouraging knowledge innovation, overcoming industrial development barriers.

Strategy 5: Fostering everyday S&T applications, stimulating interaction with society.

Strategy 6: Enhancing the defense technology system, promoting defensive arms development.

The various measures to be used to implement the foregoing strategies are listed in an appendix, and key measures are discussed in Chapter 4. The implementation of measures will be conducted through the various agencies' annual administrative plans.

Chapter 4 Vision and Key Measures

Part I Putting the S&T Policy System on a Sound Footing, Emphasizing the Effective Utilization of Resources

A. Overview

The formation of Taiwan's S&T policies previously emphasized the bottom-up assessment of units' needs, and neglected the top-down consideration of overall strategies. There was also a one-year gap between policy formation and compilation of S&T budgets, and some agencies still ran their S&T development units as provisional task forces. This state of affairs made S&T development somewhat unstable and easy to overlook. In addition, due to division of labor, S&T policy implementation and resource allocation was not fully integrated within some agencies. As far as assessment of S&T policy implementation performance was concerned, assessment indicators were not integrated across different agencies, and assessment aspects or indicators were not determined in accordance with overall S&T policy goals and strategies. As a result, the link between S&T resources and the nation's S&T policy goals was insufficiently tight.

According to the targets set in the White Paper on Science and Technology (2003~2006), gross domestic expenditure on R&D should account for 3.0% of GDP in 2006. But supposing the government's S&T budget grows by 15% in 2005 and 2006: If GDP grows by an average of 5% annually, while private R&D spending growth maintains its current 8% annual trend, then government and private R&D spending will fall short by NT$63.4 billion of the amount needed to achieve 3.0% of GDP. It is therefore urgent that the government use incentives and other measures to encourage private R&D. State-owned

enterprises, private research organizations, and nonprofit organizations currently invest relatively little in research and development. The government's mechanisms for promoting private R&D are still inadequate, and more attention must be paid to strengthening practical implementation.

While the Executive Yuan's S&T budget is allowed to grow by 15% annually, the actual rate of government S&T project growth has stayed below 10% in recent years after trimming by the Legislative Yuan. This fact highlights the need to increase private R&D. The deliberation of government S&T project funding takes the following three forms:

1. National science and technology programs:

Nine national science and technology programs are currently underway. Each national science and technology program office is responsible for reviewing funds allocated to that program within a certain scope (currently roughly 20% of S&T funding) in accordance with funding needs in the program's master plan.

2. Field review:

Agencies currently compile budgetary estimates for the current year of up to 120% of the previous year's budget amount; of this budgetary estimate, 80% may be assigned special priority, 25% assigned A priority, and the remaining 15% assigned B priority (90% could be assigned special priority and 15% each assigned A and B priority up to 2005). Agencies then submit mid-term S&T plans classified under 37 fields to the National Science Council (NSC) for deliberation purposes. The review process consists of preliminary review, follow-up review, and approval by the council meeting. While project funding within the scope of special priority is protected, A and B priority project funding is assigned in accordance with the order of priority assigned during review and the amount of approved funding for the year. The amounts of funding assigned to mid-term plans in each area are compiled by the agency; the amount for each agency is that agency's Executive Yuan-approved S&T project budget.

3. NSC S&T project review

The NSC's S&T budget currently consists of a portion subject to field review and a portion not subject to field review. Budgetary estimates for the National Applied Research Laboratories and National Synchrotron Radiation Research Center are subject to field review, while the remaining portion is reviewed by the Executive Yuan Science and Technology Advisory Group (STAG).

Several issues connected with the planning and management of national science and technology programs are urgently in need of clarification, including whether a program possesses the conditions to become a national science and technology program, issues at the organizational level, the fact that most high-level program office personnel (chairpersons and executive directors, etc.) are serving concurrently with other duties, and disjointed authority over program funding. Control of national programs is much more rigorous and complex than that of ordinary projects. The government must direct its attention to reviewing the questions of ownership of IPR resulting from the programs and how to terminate the programs.

B. Vision

1. To formulate overall science and technology development goals and strategies for the nation.
2. To put S&T policy formulation, implementation, and assessment on a sound footing.
3. To increase and find new sources of R&D funding; to boost gross domestic R&D expenditures to at least 3.0% of GDP in 2006 and thereafter.
4. To ensure the effective utilization of S&T resources by establishing performance-based government S&T budgeting mechanisms.
5. To strengthen the planning and management of national science and technology programs.

C. Key Measures

Responsible agencies: NSC, STAG, RDEC, DGBAS, MOEA, COA, DOH, CLA, MOI, MND, MOE, DF

Assisting agencies: Relevant agencies

1. Formulation, implementation, and assessment of S&T policies:
   (1) Establishment of goal and strategy adjustment mechanisms and S&T policy and performance information platforms.
   (2) Integration of S&T development control mechanisms, systematic assignment of overall S&T development goals to individual agencies.
   (3) Strengthening S&T policy formation mechanisms, establishment of a policy research center, holding regular S&T policy research forums.
   (4) Strengthening agencies' S&T management abilities.
   (5) Establishment of integration mechanisms between important related S&T development programs, public construction programs, social development programs, and defense technology programs.
2. Increasing and finding new sources of R&D funding in order to boost gross domestic expenditure on R&D to at least 3.0% of GDP by the end of 2006:
   (1) Placing more importance on S&T development, strengthening government R&D investment:
      a. Enabling government S&T budget growth of over 15% in 2006.
      b. Increasing various funds' R&D project funding support.
      c. Strengthening R&D investment of state-owned enterprises, bringing state-owned enterprises' R&D funding as a percentage of income up to private corporate standards.
   (2) Adopting specific strategy measures to encourage increased private R&D investment:
      a. Expanding government assistance mechanisms to encourage increased corporate R&D investment, extending such mechanisms to other government agencies, increasing incentives for private R&D investment.

b. Using the defense industry training reserve system or R&D alternative service to strengthen the supply of corporate R&D manpower.

c. Increasing the amount of corporate R&D loans, inducing multinational R&D centers to make R&D investments.

d. Making the research capabilities of nonprofit organizations, universities, and research organizations available for corporate use.

3. Reasonable allocation and effective utilization of government S&T funding:

(1) Formulating a performance-based budgeting system, developing appropriate S&T development performance assessment mechanisms.

(2) Expanding the existing Government Research Bulletin (GRB) system for public queries and information access.

(3) Strengthening S&T assessment, cultivating and training more S&T assessment manpower.

(4) Improvement of field review of S&T projects:

a. Top-down funding planning: Reassignment of a portion of funding from the S&T budget as top-down policy implementation project funding; this funding will be handled with a zero-base budget approach and top-down planning. Development of policy-oriented R&D topics and establishment of mechanisms for promoting interagency R&D cooperation. Employment of industry-academic cooperation to enhance the efficiency of resources utilization and create greater added value.

b. Enhancing S&T project competitiveness: In addition to the original preliminary review, follow-up review, and board approval, a field group review step will be added between preliminary review and follow-up review. The 37 fields will be divided into seven field groups on the basis of policy type; each agency's projects must compete on the basis of policy importance and expected policy benefits with other projects in the group. This will cause the projects in different areas in each group to have different growth rates and approval rates; the group review process will promote resource sharing between areas and foster interdisciplinary cooperation.

c. Continued implementation of "field strategic planning" and "performance evaluation" work will provide guidance for resource allocation and the submission of S&T projects by agencies.

d. Allocation of funds and integration of academic and field projects should be decided on the basis of policy.

e. Relevant agencies and the NSC should have full-time S&T policy support staff, supplemented with specialist and scholar committees as necessary to perform various tasks. This model will facilitate the planning of field strategies.

4. Improving planning and management of national science and technology programs:

(1) Establishment of routine "Foresight" S&T research.

(2) Strengthening of national science and technology program office powers and integration capabilities.

(3) Placing more emphasis on international S&T cooperation, strengthening accompanying manpower recruiting and training plans, strengthening protection and extension of research results (IPR).

(4) Formulation of explicit termination mechanisms for national science and technology programs, and appropriate subsequent disposition of the programs' accumulated R&D manpower, technological capabilities, and core facilities.

(5) The nine national science and technology programs will be charged with strengthening integration of up-, mid-, and downstream aspects and industry, academia, and research organizations, as well as strengthening performance evaluation and establishing termination mechanisms.

Part II Strengthening Manpower Planning and Utilization, Augmenting S&T Manpower

A. Overview

The quality and quantity of S&T manpower must be sufficient to sustain Taiwan's industrial development and boost national competitiveness. The government's S&T manpower strategies have shifted several times to support economic development throughout more than five decades of growth. Now that Taiwan has the economic structure of a developed country, it still faces severe tests of its competitiveness. Furthermore, Taiwan's slowing demographic growth and aging population will require more innovative, far-seeing thinking concerning the supply and utilization of S&T manpower resources. The following problems concerning S&T manpower have the greatest urgency: There is insufficient information on S&T manpower to support decision-making needs; S&T manpower is needed throughout almost every industry, and personnel must possess interdisciplinary, innovation, and integration skills; higher education must be better localized and the international manpower training gap eliminated; the quality of higher education must be improved; innovative training mechanisms meeting the workplace's need for rapid learning of interdisciplinary knowledge must be established; long-term holistic strategies promoting the complementary use of local and international S&T manpower must be implemented; utilization and response measures of Defense Industry Reserve Duty System should be developed in line with the principle of "primarily recruiting volunteer soldiers, secondarily drafting soldiers."

A general review of the results of the “The Science & Technology Talents Cultivation & Application Program” up to 2003 yielded numerous findings concerning the five main strategies of manpower cultivation, manpower training,

overseas manpower recruiting, manpower interchange and utilization, and creation of a superior environment. A total of 19 relevant laws and regulations were drafted, augmented, or revised in 2003, and 111 administrative measures were implemented. Looking ahead to the future, in conjunction with the plans from the Seventh National Science and Technology Conference, S&T manpower development policies from 2005 to 2008 will feature strengthened implementation of the "Executive Yuan S&T Personnel Training and Utilization Program." To bolster the country's S&T manpower resources development, policy will be guided by a long-term strategic outlook.

B. Vision

1. The country's S&T development goals for 2006 include increasing gross domestic expenditure on R&D to 3% of GDP, increasing the number of full-time (FTE) research personnel to 32.3 researchers per 10,000 population, and increasing the number of full-time (FTE) research personnel to 75.9 researchers per 10,000 employment[1].
2. To ease the S&T manpower shortfall and achieve a better balance between supply and demand, the government will strive to reduce the unemployment rate among persons with at least a college degree back to the 2000 level of 2.8% by 2006 or sooner[2].
3. Development of mechanisms for utilizing middle-age and older white collar professional manpower.
4. Strengthening implementation of S&T manpower development programs in order to bolster the country's S&T manpower development blueprint.

C. Key Measures

[1] According to projections made by the NSC Department of Planning and Evaluation.

[2] The unemployment rate among persons with a college degree or above was 2.04% in 1991, 2.15% in 1992, 2.18% in 1993, 2.23% in 1994, 2.42% in 1995, 3.13% in 1996, 2.76% in 1997, 2.8% in 1998, 2.93% in 1999, 2.8% in 2000, 3.72% in 2001, 4.28% in 2002, and 4.09% in 2003. (Source: Directorate General of Budget, Accounting and Statistics, Executive Yuan)

Responsible agencies: STAG, CEPD, NSC, MOE, MOEA, CLA, MOI, MND
Assisting agencies: DGBAS, CPA

1. Formulation of interdepartmental S&T manpower decision-making support mechanisms, provision of references to guide the drafting of S&T manpower development policy:
   (1) Integration of interdepartmental long-/short-term statistics and survey data concerning S&T manpower, implementation of value-added research and analysis.
   (2) Establishment of S&T manpower monitoring indicators, implementation of international comparisons.
   (3) Institution of systematic benchmarks for other countries' manpower policies.
2. Strengthening S&T manpower training quality:
   (1) Implementing "macro planning of higher education," boosting university S&T manpower training quality.
   (2) Encouraging the development of interdisciplinary courses, shrinking the gap between university education and industrial S&T manpower needs.
   (3) Strengthening cooperative work-study programs involving industry, academia, and research organizations in order to boost S&T manpower development.
3. Development of innovative industrial S&T manpower training mechanisms, drafting of a four-year plan for industrial S&T manpower development, establishment of an "industrial S&T manpower development promotion office":
   (1) Development of professional functions catalogs and relevant professional certification mechanism.
   (2) Acquisition of international training resources, implementation of localized development.

(3) Establishment of a professional learning environment for S&T manpower training and work practice.

(4) Training of skills developers and chief learning officers (CLOs).

(5) Establishment of S&T manpower databases assisting employment and personnel finding work.

4. Improving the functions of the industrial S&T manpower vocational training system:

(1) Implementing professional skills appraisal mechanisms for industrial S&T manpower.

(2) Strengthening internal corporate manpower development mechanisms.

5. Establishing international S&T manpower development mechanisms:

(1) Assigning certain R&D projects responsibility for promoting long-term cooperative relationships with overseas R&D resources, giving projects the goal of training global S&T manpower.

(2) Drafting and strengthening mechanisms for promoting the international interaction of domestic Ph.D.-holders.

6. Continued implementation of S&T manpower recruiting and utilization strategies:

(1) Strengthening the implementation of S&T manpower recruiting strategies and encouraging interchange in line with the concepts of "building a nest to attract a phoenix" and "one country's talent can be used by another."

(2) Performing a full-scale review of mechanisms for the utilization of male holders of M.S. degrees and above who are eligible for military service in conjunction with reform of the conscription system.

(3) Continued implementation of S&T manpower interchange between government agencies and private organizations.

(4) Active development of mechanisms for the utilization of middle-age and older S&T personnel and accompanying measures responding to the aging population and arrival of the knowledge labor era.

7. Establishing an environment in which S&T manpower provide a competitive advantage:

Continued strengthening of accompanying measures governing the recruiting of overseas professional manpower for work in Taiwan.

Part III Boosting Academic Research Standards, Developing Distinctive Academic Fields

A. Overview

While domestic academic research standards have improved much thanks to diligent efforts over many years, there is still some way to go before they can match the highest world standards. Most public universities have run into developmental bottlenecks in recent years, and the ongoing expansion of higher education has meant that educational resources are spread thin. The quality of university education has continued to deteriorate, and universities are insufficiently international. In particular, the international trend towards pursuit of excellence by universities has made it urgent that Taiwan's universities raise their academic standards. In summary, public universities have encountered the following problems in recent years: (1) the expansion of higher education has diluted the allocation of educational resources; (2) the quality of university education has deteriorated steadily; and (3) university education in Taiwan is insufficiently international.

Academic research results can lend impetus to industrial innovation, and sound relationships between universities and industry can also boost industrial innovation. Promoting industry-academic relationships is thus considered an important means of enhancing industrial innovation. Industry-academic relationships in the leading countries are gradually becoming institutionalized, formalized, and sustained. Universities cooperate closely with companies in countries with thriving industry-academic relationships, and universities also participate extensively in industrial research. These countries' diverse relationships approaches include corporate personnel serving on schools' boards of directors, corporate researchers participating in school research and teaching, and the formation of limited liability R&D partnerships. In comparison with

other countries, Taiwan's industrial development background and organizational systems have kept industry and universities apart; more work must be done to bring the two together for the sake of R&D innovation.

Taiwan is surrounded by the sea and has access to plentiful marine resources. It is one of the world's twenty major fishing nations. Taiwan has a high level of marine biodiversity, and one-tenth of the world's known marine organisms have been found in its waters. As a maritime nation, Taiwan must regard marine research, development, protection, and sustainable utilization as inescapable issues. In addition, marine research has local, regional, and exclusive significance. Taiwan's marine research capabilities have gradually approached international standards. The following problems must be resolved if domestic research is to make further progress: (1) Research vessels are old and have insufficient tonnage. (2) Data is scattered and surveys have lacked adequate planning. (3) Marine research manpower is insufficient. (4) There is no dedicated organization to organize marine research matters. (5) There is no established coastal resource conservation ethic.

The new interdisciplinary field of green technology seeks to find environmentally-friendly alternatives for conventional technologies. Green technology promises to use innovative research to passively lessen existing pollution and actively guard against future threats, while balancing the needs of the environment, energy, and ecologically sustainable development. Green technology is a major international trend, and is spinning off distinctive academic fields. Although many of Taiwan's major industries, such as the computer and semiconductor industries, are world leaders, they are primarily concerned about economic development and capacity expansion, and have given little thought to industry's negative impact on the environment. The country as a whole has not had any specific green technology strategies or sustainable alternative programs. While past green technology research has chiefly focused on resolving existing problems, the rapid emergence of biotechnology and

nanotechnology has drawn attention to the sustainability of new technologies, and provided a fresh moment of opportunity for the development of green technology.

Taiwan's main space technology development goals have been to develop and maintain the organization, technology, and manpower resources needed for a space program, and to develop three satellites. The government hopes that the satellite program will gradually build up the nation's space technology capabilities. Radiation from Taiwan's existing Synchrotron Light Source has high irradiance and low energy, which is not ideal for the production of X-rays. Furthermore, not enough beamline time is available for the nation's needs, and usable radiation ports have all been taken. These shortcomings have put a brake on the nation's long-term S&T development.

Among the various types of academic research projects, ordinary specific-topic research projects are numerous and relatively inexpensive; this type of project forms the mainstay of academic research in Taiwan. Review and approval procedures for specific-topic research projects are extremely rigorous. These procedures may also serve to guide the formation and assessment of large-scale academic research projects. The project application and review system is fair and efficient. Applications may be made and materials sent for review over the Internet. The review process starts with a preliminary review of projects in the same field, which is followed by a follow-up review. Researchers are encouraged to apply for multi-year projects. Mechanisms have been established to ensure flexibility in the disbursement and use of funds.

B. Vision

1. Development of world-class universities and research centers:

The government must rely on the planning of educational resources, the encouragement of key academic research fields, and the rewarding of excellent teaching to develop first-rate international universities and make Taiwan a top

Asian research center. Specific goals include the establishment of at least 15 top-flight departments and graduate schools and having an interscholastic research center achieve top ranking in Asia within five years, and transforming at least one university into a first-rate international university within ten years. (The standard for a first-rate university is ranking within the top 100 universities worldwide or being on a par with one of the top 80 universities in the US.)

2. Boosting industry-academic relationships, pursuing excellence and innovation:

(1) Separating civil service and teaching position, loosening the system.

(2) Industrial technology R&D performed at universities and research organizations should focus on both technology authorization and the utilization of R&D results so as to create new technology-based startups.

(3) Encouraging interdepartmental cooperation in attracting multinational corporations' R&D centers, domestic corporate R&D centers, and cooperative inter-academic R&D undertakings.

(4) Promotion of regional industry-academic technology interchange mechanisms relying on the strengths of technology service firms, or linking technology trading markets with university intellectual property (IP) management or technology transfer offices.

3. Strengthening marine S&T, green technology and interdisciplinary frontier research capabilities:

(1) Establishment of a national marine research/training fleet and technology support team, establishment of a supporting organization and relevant laws and regulations, establishment of dedicated national marine R&D organization.

(2) Promoting the establishment of high added value, high interdisciplinary integration green technology industries in the fields of biomedicine, semiconductors, computers, and communications.

(3) Planning the establishment of the Taiwan Photon Source (TPS), and laying out new directions for the development of space science and technology.

C. Key Measures

Responsible agencies: MOE, NSC, MOEA, MOI, COA, CGA, MOTC, DOH

Assisting agencies: AS, CEPD, STAG, EPA, CCA, CIP

1. Development of international-class universities and research centers:
   (1) Encouraging the integration and merger of research universities so as to expand the scale of operations; making universities independent nonprofit entities; strengthening universities' competitive positions.
   (2) Providing incentives for the establishment of key departments and graduate schools with distinctive instruction.
   (3) Putting the planning and utilization of higher education funding on a firmer basis.
   (4) Internationalizing research teams, establishing mechanisms for cooperation with foreign universities and research organizations.
   (5) Promoting the internationalization of academic research, integrating the research oversight functions of the MOE, NSC, and MOEA, etc., establishing manpower exchange mechanisms.
2. Boosting industry-academic relationships, pursuing excellence and innovation:
   (1) Transforming universities into independent nonprofit entities so as to allow the free flow of R&D personnel between academia and industry.
   (2) Revising relevant regulations so as to allow instructors to participate in industry-academic cooperation incentive mechanisms:
      a. Revisions of the Statute Governing the Appointment of Educators and the Teacher Law so as to ease regulations governing instructors' part-time administrative duties.
      b. Revision of the Statute Governing the Appointment of Educators so as to ease restrictions on investments by instructors at public colleges and above.

c. Revision of the Statute Governing the Appointment of Educators so as to ease regulations governing the loan of instructors to government agencies.

d. Revision of the School Teacher and Staff Retirement and Condolence Payment Statute so as to ease regulations governing the calculation of years of seniority for instructors on loan.

(3) Improvement of university teaching and courses in order to train manpower needed by industry:

a. Expanding implementation of "final mile" pre-employment courses, allowing industry personnel to participate in course planning.

b. Continued implementation of returning student education, planning of advanced study channels for in-service personnel.

(4) The MOE, NSC, and MOEA will draft incentive measures to encourage universities that have successfully promoted industry-academic cooperative R&D.

(5) The MOEA will establish a university-industry cooperation promotion committee and a program office in order to promote industry-academic cooperation on a sustained basis. The MOEA will also encourage industry associations and city/county industry groups to call on their members to engage in cooperation.

(6) MOEA-funded university research centers or S&T programs (academic technology development programs) must explicitly state industry participation procedures.

(7) MOEA-funded S&T projects conducted by research organizations must explicitly state university participation mechanisms.

3. Strengthening marine S&T, green technology research, and interdisciplinary frontier research capabilities:

(1) Strengthening marine S&T research:

a. Designing and building multipurpose research vessels in different classes; the first priority is to build a 2,000-ton research vessel.

b. Training professional marine R&D manpower.

c. Integrating marine research surveys and marine data, incorporating the National Marine Center in the National Applied Research Laboratories.

d. Integrating marine research from coast to open ocean, integrating earth science, atmospheric science, and oceanography.

e. Budgeting funds for marine ecology education, research, and protection; planning and establishing ecological preserves.

f. Strengthening long-term scientific research on marine ecosystems, marine resources, and marine organisms.

g. Establishing Taiwan as an international earth system scientific observation and experimentation platform.

h. Promotion of research on the "collection and preservation of the cultural assets of Taiwan's nautical peoples."

i. Using marine science and technology to develop relevant industries.

(2) Development of green technology research:

a. It is recommended that a certain percentage of the national science and technology program budget be allocated to green technology research.

b. Planning and establishment of interdisciplinary green technology research teams, active recruiting of interdisciplinary manpower needed for S&T research in the fields of bioinformatics, biomedical testing, semiconductors, communications and computers, energy, and environmental protection, etc.

c. Incorporation of the green technology concept in the formulation of industrial policies and relevant laws and regulations.

d. Promotion of interdisciplinary integrated research on green technology.

e. Implementation of green technology management personnel training at the soonest possible date.

f. Promotion of "R&D on alternative materials eliminating industrial pollution sources" and incorporation of green technology in industrial processes.

(3) Strengthening interdisciplinary frontier research capabilities:

a. Study of the feasibility of establishing a Taiwan Photon Source.

b. Planning of new directions for the development of space S&T:

i. Mission-oriented satellite programs: In accordance with the needs of the nation and users, satellites will meet mission goals as their first priority, with technology transfer as a secondary consideration. Satellites will be developed via international cooperation.

ii. Satellite technology development programs: Expansion of industry, academic, and research participation; citizens should bear full responsibility for program implementation, with foreign assistance only when necessary. Completion of a Taiwan-built satellite system within six years.

iii. Satellite applications programs: Application and extension of satellite data.

iv. International cooperation: Participation in world-class space research teams performing forward-looking research.

c. Consideration of astronomical observations and cosmology research.

4. Improvement of academic research project assessment and funding mechanisms:

(1) Planning guidelines for academic research projects should prioritize establishing a domestic R&D environment and enhancing international cooperation. Projects should strive to improve international competitiveness.

(2) The government should formulate clear-cut performance indicators, such as benefit to science and industry or expected major breakthroughs, etc.

(3) Large-scale academic research projects should publicly solicit proposals. Review of applications, approval, and assessment of results should be conducted in accordance with rigorous, internationally-recognized standards. Projects of the same type and requiring the same general amount of funding should be compared with each other. Deliberation and evaluation committees should be constituted from domestic and foreign experts and specialists. Projects can be implemented via a two-stage approach: To

ensure project goals are reached, two or more project teams can work simultaneously during the first stage, and the team with the best performance allocated to continue implementation during the second stage.

(4) Objective, professional deliberation committees should discuss and compare large-scale academic research projects and core facility projects in a fair, open, and transparent manner during the planning stage. The committees' findings will guide decisions concerning whether to continue implementation. Project assessment should consider team implementation ability, consensus of the S&T community, international competitiveness, contribution to the domestic S&T community, competition for funding, ratio of funding to that of an ordinary project, and mid-term and final evaluation mechanisms.

(5) If large-scale academic research projects or core facility projects are evaluated as having poor implementation performance, the research teams may be asked to make major revisions in project content; project termination mechanisms should also be formulated to deal with such cases.

(6) NSC specific-topic research project applicants should be encouraged to apply for multi-year projects. Long-term projects are better able to reveal project performance and substantive content, and are easier to deliberate. And to facilitate project implementation, regulations governing multi-year funding and item utilization should be made more flexible.

Part IV Encouraging Knowledge Innovation, Overcoming Industrial Development Barriers

A. Overview

1. The importance of S&T innovation

The world's leading nations will rely on the knowledge economy for growth in the 21st century. The knowledge economy has quickly brought about the reform of the global economic system and focused worldwide attention on national innovation systems. The most important issues connected with the knowledge economy are the establishment of mechanisms for the creation, management, utilization, and protection of intellectual property (IP), and the development of an adequate technology innovation environment able to strengthen industrial technology innovation and utilization, and promote the development of a domestic innovation economy.

The relationship between science and industrial development has become increasingly close over the last few years. Many new industrial technologies have originated directly from scientific research, multinational firms with international clout are getting more deeply involved in basic research, and the industrial value of universities' scientific knowledge is rising steadily. Due to these trends, promoting industry-academic relationships has become a key method of boosting industrial innovation. While most past industry-academic relationships were short-term, informal partnerships, they have been growing more lasting and formalized in recent years. However, more effort must be made to promote industry-academic relationships fostering innovative R&D.

2. Knowledge innovation in industry

Taiwan's manufacturing industries have made great strides in lowering costs, instituting process improvements and strengthened operations management, outsourcing production, and implementing overseas investment and division of labor. On the other hand, domestic companies are still under

huge pressure from competitors in newly-industrialized countries with inexpensive labor and resources. Beyond cutting costs, boosting competitive advantage will require using Taiwan's impressive manufacturing experience to create new technological applications and innovative models, and promote the development of service industries enhancing added value. While service industry already accounts for 67.1% of GDP, service firms account for only 7% of corporate R&D, which is far lower than the 25%~33% found in most of the world's leading countries. The strategy of "Promoting Knowledge Innovation and Overcoming Industrial Development Barriers" must therefore emphasize innovative, technology-minded service industries with new business models. Apart from providing focused encouragement and expanding the scope of relevant surveys, the government must also take advantage of market mechanisms and increased competition to stimulate more service industry R&D and innovation.

Domestic industrial innovation usually takes the form of progressive technology acquisition and improvement. Original innovation will be required to raise industrial development to a higher level and breathe fresh life into industry's competitive advantage.

B. Vision

1. Strengthening IP management and achieving superior IP competitiveness: Boosting IP innovation, value-adding, circulation, and application.
2. Promoting high-value innovative industrial technology R&D systems and transforming Taiwan into an Asia-Pacific regional technological service hub: Overcoming the "thin profit margin problem," creating "IP value," nurturing domestic technology service value-added manufacturing industries, and expanding domestic companies' share of foreign technology service markets.

C. Key Measures

Responsible agencies: MOEA, MOE, NSC, MND

Assisting agencies: CCA, COA, STAG, CEPD, EPA, CHA, CIP

1. Putting industrial technology innovation IP mechanism on a sound footing:
   (1) Establishment of integrated, coherent mechanisms for IP creation, protection, and utilization.
   (2) Strengthening and expanding IP management and utilization systems established by industries.
   (3) Improving IP review quality and management performance in order to realize IP protection.
   (4) Strengthening IP appraisal management and financing security mechanisms in order to strengthen the IP trading environment.
   (5) Promoting integrated IP information interchange service platforms and encouraging the development of an IP technology service industry.
   (6) Planning and establishing IP training institutes in order to broadly train domestic IP specialists.
2. Putting the industrial technology innovation system on a sound footing:
   (1) Increasing linkage of industrial technology innovation value chains: Encouraging manufacturers to develop brands and tap emerging markets, emphasizing business models combining technological R&D with market demand, boosting linkage between innovation chain members and international networks.
   (2) Strengthening industry-academic technology innovation chains: Encouraging universities to license technology, promoting startups based on university-developed technologies, and fostering the commercialization of university-developed knowledge.
   (3) Promoting the commercialization of defense technology, encouraging the formation of defense industry clusters.
   (4) Formulating strategies for participation in the drafting of international standards, which will help the country keep up with industrial innovation trends.

3. Promoting the development of promising emerging technology-based industries:

(1) Promoting the development of industries connected with e-family applications, next-generation mobile communications, intelligent medical care, and portable green power sources.

(2) Establishing development mechanisms for diverse industry clusters and industrial parks taking advantage of local features and the energy of the private sector.

(3) Establishing superior incubation center mechanisms, improving the incubation environment for technology-based startups.

4. Helping value-added conventional industries to upgrade and transform themselves:

(1) Helping conventional industries to perform innovative R&D and develop autonomous core technologies.

(2) Promoting knowledge use by conventional industries, enhancing conventional industries' knowledge creation capabilities.

(3) Promoting technology use by conventional industries in order to increase added value.

(4) Promoting a move to higher value by conventional industries, strengthening operating performance and design abilities.

5. Promoting the development of knowledge service industries:

(1) Fostering a sound development environment for technology service industries: Boosting the capabilities of technology service companies, strengthening technology service industry manpower resources, helping companies to expand their markets, and improving the legal environment.

(2) Strengthening commercial service industry's development environment, promoting commercial technology innovation and utilization.

(3) Enhancing the innovation capabilities of small and medium knowledge service companies, bringing the knowledge service industry up to international standards.

(4) Establishing a technology application and innovation model fostering the emerging of new technology-driven service enterprises.

6. Easing legal and regulatory obstacles:

(1) Revision of the Patent Law to adopt an injury appraiser system and ensure conformity to world trends.

(2) Drafting of the "Patent Appraiser Law" in order to include patent appraisers among professional occupations and technical personnel, establish a patent appraiser system, and enhance IPR application and protection standards.

(3) Revision of the "Regulations Governing Investment Tax Credits for Corporate Research and Development and Manpower Training Expenditures" to specify applicable service industry R&D activities and ensure that service firms may receive investment tax credits for R&D.

(4) Drafting of the "Commercial Development Research Institute Establishment Statutes" with the ultimate goal of promoting commercial innovation and enhancing the country's international competitiveness.

(5) Drafting of the "Financing Company Act" in order to provide more channels for funding, invigorate the domestic funds market, and promote international standards in the area of financial trading.

Part V Fostering Everyday S&T Applications, Stimulating Interaction with Society

A. e-Taiwan and e-Life

1. Overview

With the increasing maturity of information technology, information systems are playing a growing role in medical care, and medical information systems have become the focus of much international industrial research attention. But while several major domestic conferences have made important recommendations concerning the integration of medical information and improvement of treatment quality, information integration is still insufficient, policies are still behind the times, information investment is still low, and professional manpower is still in short supply.

Furthermore, the advance of science and technology has spawned a growing number of ethical and legal disputes. Problems connected with information technology include legal challenges involving freedom of speech, intellectual property rights and information privacy, as well as insufficient awareness of information ethics. Problems connected with biomedical technology include the use of stem cells in the prevention and treatment of disease and the use of genetic databases. Since the existing legal system is inadequate to deal with these challenges, it is important that the government draft regulations to meet the new ethical and legal needs.

In the field of transportation, intelligent transportation systems (ITS) will gradually enter the world mainstream and become an important tool for easing transportation problems and integrating transportation systems. While ITS in Taiwan is approaching the full-scale deployment stage, a number of problems have emerged that must be addressed soon.

The establishment of a "Taiwan Encyclopedia" knowledge base is an

important task that will underscore Taiwan's cultural uniqueness, inspire a new knowledge movement boosting the people's cultural citizenship, and promote cultural networking with the ultimate goal of an "e-Taiwan" collection. The Taiwan Encyclopedia will also enrich elementary and middle schools' supplementary teaching materials and thus strengthen the foundation of the knowledge economy.

Throughout the realization of e-life, a secure and reliable online environment will be essential to government effectiveness and corporate competitiveness. Of course the nation's information and communications security problems should not be seen as merely "technical issues." Instead, relevant policy issues and response measures should be proposed from the point of view of the country's lasting security and peaceful development. The resources of industry, government, academia, and the research community must be integrated to create trustworthy mechanisms and safeguard the privacy of personal information. The government should strive to achieve the goals of a "secure and reliable knowledge economy age information society" and "ensuring that the country possesses a secure and reliable information and communications environment" by 2008.

The information industry has played a major role in Taiwan's economic growth and rising global competitiveness since the 1970's. The benefits of the information revolution have not been spread evenly, however, and many leading countries have been pondering the digital divide and the effect of information technology on social justice. The government must therefore come to grips with the issues of how ubiquitous information technology can promote the sharing of cultural resources and play the role of a social equalizer, and how information and knowledge once available only to the elite can be spread throughout society and foster social equality.

2. Vision

(1) Integration of medical information and improvement of treatment quality.

(2) Development of biotechnology and information technology, establishment of technology ethics and legal systems.

(3) Application of innovative technology in transportation, e-transportation, sustainable transportation.

(4) Establishment of a Taiwan Encyclopedia knowledge base, promotion of cultural networking.

(5) Establishment of a secure and reliable information and communications environment.

(6) Shrinking the digital divide, enhancing digital human rights.

3. Key Measures

Responsible agencies: RDEC, DOH, MOTC, CCA, AS, STAG, MOI, CIP, MOE, NSC

Assisting agencies: Other relevant agencies

(1) Integration of medical information and improvement of treatment quality:

a. Establishment of a personal health data network and integration of personal health information; linking of relevant databases to create a health information grid able to improve treatment quality.

b. The government must place more emphasis on manpower training and relevant industry promotion measures, while strengthening health information privacy and security measures.

(2) Application of innovative technology in transportation, e-transportation, sustainable transportation:

a. Active participation in international standard organizations and training of intelligent transportation system (ITS) manpower, development of localized analytical models, drafting of technical standards, and development of certification technologies and procedures for interface standards.

b. Collection of e-transportation information, establishment of information processing and dissemination platforms, investigation of ITS system performance assessment methods, establishment of sustainable

maintenance and operation mechanisms, and strengthening of research on certification technologies and electronic labeling technologies, etc.

(3) Establishment of a Taiwan Encyclopedia knowledge base and promotion of cultural networking:

a. Use of knowledge management systems and open communications platforms to give access to knowledge back to the people. A jointly constructed knowledge base of Taiwan's history and culture will serve as a repository for memories of different periods, shape citizens' consciousness, and create a new concept of Taiwan.

b. Use of modern cartographic technology to develop and publish thematic maps of Taiwan, a world atlas, and relevant websites showing the multifaceted relationship between Taiwan and other countries of the world. Development of elementary and middle school supplementary teaching materials and ethnic language study materials intended to revitalize the country's cultural endowment. Use of the Internet to project the country's knowledge power.

(4) Development of biotechnology and information technology, establishment of a technology ethics and legal system:

a. Establishment of development platforms promoting technological development and protecting the public interest. Strengthening laws and ethical standards governing the use of medical and genetic databases.

b. Establishment of legal protections and transparency mechanisms in connection with genetic databases. Strengthening of specialized manpower training. The government must squarely address the relationship between technology development, deliberative democracy, and public participation and oversight.

(5) Establishment of a secure and reliable information and communications environment:

a. Inducing government agencies to budget information security expenses. Strengthening public awareness of information, communications, and Internet security, training specialized information security manpower,

establishing a licensing system to raise professional standards, and implementing the steady long-term training of information security manpower.

b. Revising and augmenting information security laws, regulations, and standards in response to international information security development trends with the goal of curbing Internet crime and providing better online identification capabilities. Integrating the resources of industry, government, academia, and the research community to establish national information and communications security and reliability mechanisms safeguarding the privacy of personal information.

(6) Shrinking the digital divide, enhancing digital human rights:

a. Improving all citizens' information skills and shrinking the urban-rural digital divide through the use of existing administrative resources and the facilities of schools and libraries, etc., while providing incentives to participating businesses and nonprofit organizations.

b. Helping developing countries shrink their digital divides through "technological diplomacy" following the model of Taiwan's past overseas agricultural missions.

B. Environmental Science and Technology and Sustainable Development

1. Overview

The people of Taiwan are increasingly concerned about environmental protection, and economic development is no longer seen as the sole aim of modernization. Citizens eagerly look forward to the improvement of the living environment. Environmental issues such as waste disposal, the implementation of environmental risk management measures, and the accelerated installation of sewer systems are important in Taiwan and also in many other countries around the world.

The global environment is changing rapidly. Assessment mechanisms, early warning systems, and risk management measures with the goal of sustainable

development must be deployed to reduce environmental impact. The country must gain an understanding of environmental change, gather information needed for decision-making, and be able to formulate response strategies.

Taiwan's geography and geological environment are unique. Natural disasters such as typhoons and earthquakes are common. In addition, Taiwan's conventional heavy industry and burgeoning high-tech industry have caused growing numbers of human accidents. Taiwan must strengthen environmental conservation and land use management, continue to improve the environment, and reach the vision of sustainable development. The country must also invest in disaster mitigation technology R&D and establish disaster management mechanisms.

In light of world trends and the urgency of domestic water resource problems, the government must focus on water-intensive industries, transfer appropriate technology to these industries, guide their development, and ensure that market mechanisms are in control of water use.

Energy prices have risen steadily, and the global energy environment will keep changing in the future. Much needs to be done to promote the renewable energy industry, and the government must continue to develop and apply applications of energy technology with the goal of realizing renewable energy, new ways to use energy, and conservation.

2. Vision

(1) Strengthening recycling and fostering green industries, establishment of an integrated environmental health risk assessment and management system, and improvement of environmental quality.

(2) Establishment of key technologies and early warning and risk management mechanisms in order to lessen environmental impacts, respond to global environmental changes, and achieve the goal of sustainable development.

(3) Strengthening disaster relief and early warning technology assessment R&D and applications, establishment of a complete monitoring system, enhancing disaster response and early warning capabilities.

(4) Promoting knowledge use by water-intensive industries and the commercialization of water use knowledge in order to create new water-intensive industries and effectively use water resources.

(5) Shifting focus to renewable energy, new ways to use energy, and energy conservation. Relying on technological innovation and Taiwan's industrial strength to enhance international competitiveness.

3. Key Measures

Responsible agencies: EPA, MOEA, MOI, NSC

Assisting agencies: DOH, COA, MOTC, STAG

(1) Improvement of environmental quality:

a. Promoting source reduction and recycling, establishment of environmental science and technology parks, generating green recycling industry cluster effect.

b. Promoting an integrated product policy, strengthening clean production, encouraging green consumerism.

c. Strengthening waste management, promoting a full waste sorting, zero waste policy.

d. Implementing integrated environmental health risk assessment and management.

e. Promoting the construction of sewer systems and the effective utilization of technological resources.

(2) Responding to global environmental changes:

a. Establishment of systemic, integrated response mechanisms.

b. Planning the establishment of a dedicated research organization or national program to integrate the implementation of relevant research.

c. Establishment of environmental change early warning mechanisms and indicators.

d. Participation in international environmental protection activities, strengthening cooperative relationships with international global change research organizations.

e. The government decision-making process and disaster mitigation issues should be incorporated in global environmental change impact assessment.

(3) Disaster mitigation technology R&D and extension of applications:

a. Increasing disaster mitigation and relief database funding and manpower.

b. Development and acquisition of advanced monitoring technology and equipment, integration and deployment of monitoring networks.

c. Strengthening research on the application of aerial photography and FORMOSAT-II and -III data in disaster mitigation and relief work.

d. Strengthening research on the earthquake damage assessment system and its application.

e. Strengthening earth science surveys and research on the mechanisms and spatial/temporal changes and characteristics of earthquakes, typhoons, floods, and landslides.

(4) Development of knowledge-based water-intensive industries.

a. Promotion of the recycling, reuse, and regeneration of wastewater.

b. The government should quickly build privately-operated seawater desalination plants with or without private investment.

c. Establishment of a deep seawater resource industrial park within two years.

d. Improving hot springs development technology from the current state, putting hot springs management on a sound footing.

e. Providing incentives for private investment in reservoir silt recycling and reuse zones.

(5) Development of energy technology applications:

a. Making full use of the R&D capabilities of academia, research organizations, and industry to strengthen the linkage between up-, mid-, and downstream energy technology R&D and develop localized energy technology.

b. Strengthening forward-looking research applying biotechnology and nanotechnology to energy, with the intention of enhancing the country's R&D capabilities and shortening the technology R&D process.

c. Strengthening forward-looking applications research involving renewable energy.

d. Accelerating the development of high efficiency, high quality, low cost fuel cell technology.

e. Development of key technologies used in clean hybrid vehicles.

C. Quality of Life and Technology in People's Lives

1. Overview

As for quality of life and application of technology in people's lives, disease prevention and medical technology will continue to be increasingly important in Taiwan's aging society, and much medical technology R&D will focus on early diagnosis and early treatment.

Housing is another basic social need. Due to reconstruction after the 921 earthquake and people's demand for better housing and quality of life, recent housing construction and renovation needs have been greater than in the past. There are many poorly managed construction firms, however, service quality is by no means stable, and housing construction and maintenance consume vast amounts of resources.

There is no unified government authority in charge of private construction companies. Public construction is very ineffective and standards are incoherent. Loss of raw data is a big problem. It is therefore urgent that the government promote the networking and standardization of the construction industry.

Due to overexploitation of the environment and nature, Taiwan is unattractive, the ecology has declined steadily, and natural disasters have occurred in rapid succession. Beyond affecting the living environment and quality of life, this state of affairs has also had a negative impact on economic development. More innovative thinking should be applied to the use of living

space, protection of the environment and ecology, energy conservation, the creation of urban and rural landscapes, and land planning. Our goal should be to foster harmony between nature and mankind, reduce the incidence of natural disasters, improve citizens' quality of life, and create a uniquely Taiwanese style and culture.

Existing laws and regulations are insufficient to govern the biotech and medical products that have emerged in the wake of genomic and proteomics research. Responding to this situation, Taiwan has established the Center for Drug Evaluation (CDE), increased the number of regulatory personnel, and implemented active management. Further efforts to improve the legal environment must include simplifying management while allowing for risk, strengthening international cooperation, and improving the performance of management personnel.

2. Vision

(1) Shrinking the north-south gap in nuclear medicine quality, building a superior radiopharmaceutical R&D environment, strengthening cooperation with international research organizations, establishing strategic alliances within domestic industry, fostering cooperation among industry, academia, and research organizations, and establishing a niche in radiopharmaceutical supply and technology creation and export.

(2) Putting management of construction firms on a sound footing, ensuring that consumers can obtain construction information, and promoting applications of technology in construction in order to improve housing quality.

(3) Combining innovative thinking with technology, cultural characteristics, and social values to create a uniquely Taiwanese style and culture, and improve quality of life.

(4) Establishment of a comprehensive legal and regulatory environment able to simplify management, strengthen international cooperation, and enhance the

performance of management personnel, and thereby promote the development of biotechnology and medicine.

3. Key Measures

Responsible agencies: MOI, AEC, PCC, MOE, DOH

Assisting agencies: NSC, MOEA, CPC, MOTC, EPA, CCA, COA

(1) Creating a superior radiopharmaceutical R&D environment, actively training professional manpower, shrinking the north-south gap in nuclear medicine quality.

(2) Establishment of major core technologies, strengthening R&D and marketing capabilities, participating in national biotechnology and pharmaceutical development programs, and achieving full mutual sharing of the core facilities and hardware and software resources of domestic organizations.

(3) Establishment of a comprehensive nuclear medicine information network, enhancement of radiopharmaceutical manufacturing quality, strengthening of cooperation with international research organizations, and promotion of strategic alliances within domestic industry.

(4) Drafting of home construction industry development strategies, performing surveys of construction firms, surveying consumer satisfaction in home construction quality, compilation of practical home construction handbooks.

(5) Strengthening construction management, formulating public construction information exchange standards, promoting applications of technology in construction.

(6) Promoting online bidding, document and design drawing version management, and data review management in the public construction industry.

(7) Implementing "creativity education" starting in elementary school, planning creativity training courses, holding "superior campus spatial creativity

contests," strengthening university "practical creativity" training, revitalizing university education.

(8) Promoting "superior spatial creativity contests"; implementing planning spanning personal living space, the community, organizations, city and country, and the nation; encouraging large corporations to participate in "everyday life creativity" contests, incorporating technology, creativity, art, and culture to achieve stylistic diversity and distinctiveness.

(9) Strengthening biotech drug management and legal awareness education, improving the pharmaceutical industry environment, firmly grounding the clinical testing system and its operating mechanisms, implementing certification services.

(10) Promoting drug epidemiology research, establishing a drug management system grounded in empirical science and prioritizing consumer protection, simplifying procedures and working to achieve standardization, globalization, and smart management.

Part VI Enhancing the Defense Technology System, Promoting Defensive Arms Development

A. Overview

Due to Taiwan's special political and economic circumstances, the effective promotion of defense technology research and private participation in the arms industry will require an understanding of the need for "combat-oriented weapons system" defense technology and arms industry. It will also require the determination of technology items and systems conforming to the country's industrial capabilities and optimal strategic utilization and development of manpower, funds, and resources so as to balance defensive strength against industrial development.

The country's defense industry policy has long rested on a foundation of obtaining arms, and policies have focused on the acquisition of weapons systems and equipment. There was previously little private investment in the defense industry. Civilian industry and the defense industry developed in almost complete isolation from each other, and the private sector had few opportunities – and little willingness – to participate in the defense industry. There were thus few chances to apply private technology for defense purposes.

If the country is to develop arms technology via civilian-military cooperation, it must therefore look to successful examples of arms development in the industrialized countries. It must also take urgently needed defensive arms that conform to the country's existing industrial capabilities and key developing industries as the focus of technology and industrial development efforts. It must be borne in mind that achieving an economic scale sufficient to compete internationally and be profitable will depend on the country's existing industrial foundation, market development capabilities, and international channels. A successful defense industry can contribute to defense technology R&D and form

part of an organic defense industry value chain system.

B. Vision

1. Establishment of a national "advanced defense technology research mechanism" organization framework channeling the capabilities of industry, academia, and the research community into advanced defense technology development.
2. Establishment of an internationalized defense technology industry capable of creating dual purpose technologies and supporting major defensive arms equipment and systems over the next thirty years.
3. Establishment of a globally-competitive defense information and communications electronics industry able to thrive in defense technology and arms development niches and conforming to the nation's industrial goals.
4. Establishment of defensive arms development in order to lastingly sustain democratic values and creation of international marketing decision-making mechanisms and industrial business models.

C. Key Measures

Responsible agencies: MND, STAG, MOEA, NSC
Assisting agencies: MOE

1. Establishment of forward-looking defense technology R&D mechanisms:
   (1) Establishment of advanced defense technology research mechanisms.
      a. Planning of the establishment of advanced defense technology research mechanisms must reflect national sentiments, and must feature resource sharing and integration with the existing administrative system. An effort must be made to increase private willingness to participate and augment defense technology capabilities.
      b. The government must establish a comprehensive mechanism for the functioning of the Defense Industry Development Fund, expanded funding,

and encourage private universities and research organizations to participate in advanced technology R&D.

c. Utilization of the resources of industry, academia, and research organizations to facilitate the major adjustment, merger, or streamlining of existing defense technology R&D and defense industry organizations and implementing units, ensuring that defense technology R&D and defense industry development can effectively meet the need for defense autonomy.

(2) Appropriation of a reasonable budget and subsidies to encourage private participation in relatively risky advanced defense system and technology R&D efforts and dual-use technology development projects.

(3) Securing international cooperation opportunities for domestic industry via foreign weapons system orders, acquisition of key defense technologies, harnessing the joint participation of R&D units, universities, and industry to enhance domestic technology.

(4) Establishment of a technology and business management assistance center helping the private sector build up its development and manufacturing capabilities.

(5) Establishment of defense contractor assessment and grading and military goods certification system.

(6) To encourage companies to engage in R&D, the government should establish incentives for self-funded private advanced weapons system and technology R&D, perform demonstration and assessment of the resulting products and technologies, establish rights protection mechanisms, and draft preferential incentive laws and regulations.

(7) Establishment of a mechanism for the selection and management of R&D and procurement items to promote the development of defense industry.

(8) Promotion of forward-looking, integrated defense technology research projects jointly commissioned by industry and government and performed at universities and research organizations.

(9) Establishment of a defense technology grading mechanism, increasing the amount of the defense technology budget earmarked for competitive contracts.

a. Incorporation of the defense technology budget in the government's S&T budget system; the government should plan and integrate the amount earmarked for competitive contracts from a holistic point of view.

b. Expansion of the defense technology R&D budget in order to attract and retain talented personnel on a sustained basis.

c. The grading of defense technology may be performed on the basis of "meeting national needs." The budget amount allocated to competitive contracts should be managed using America's SBIR model. Competition via parallel contracts should be used initially, followed by an integrated selection approach, with a final emphasis on implementation.

2. Strengthening the defense technology manpower training and utilization system:

(1) Drafting of the "Defense Education Law" to firmly establish the country's defense technology education development policy.

(2) Strengthening the creation of a "defense technology manpower database" in cooperation with the NSC. This database will serve as a defense technology R&D manpower integration platform.

(3) Making strong efforts to retain or transfer important retiring instructional personnel with defense technology knowledge.

(4) Planning the establishment of a "weapons system center" responsible for training defense technology integration specialists and identifying and integrating key defense technologies.

(5) Taking advantage of the "academic cooperation" and "industry cooperation" panels of the Defense Technology Development Commission, along with industry cooperation, to realize a cooperation model involving industry, academia, and research organizations.

(6) Establishment of a defense training reserve system and long-term S&T manpower training linkage mechanisms.

(7) Assessment of the feasibility of establishing a "defense training reserve feedback fund" for the purpose of improving defense assessment and review mechanisms.

3. Promoting private participation in weapons research:

(1) Drafting of Executive Yuan defense industry promotion and guidance mechanisms encouraging deep private involvement in the defense technology industry.

(2) Commissioning the establishment of a "defense technology management research center" by a private university, and development of this center as a permanent defense technology and weapons knowledge platform.

(3) Establishment of an "industry cooperation decision-making and assessment system" able to make the most effective use of the industry cooperation budget and improve R&D capabilities.

(4) Accelerating the reorganization of the Chung Shan Institute of Science and Technology as a nonprofit research organization, attracting outstanding defense technology R&D manpower.

(5) Use of the "Defense Industry Development Fund" to provide needed funds, information, and technology to companies.

(6) Continuing implementation of a government-owned, privately managed system at armaments factories, accelerating the participation of private enterprises in defense technology and defense industry, particularly in the role of strategic contractors involved in highly sensitive and long time-frame armament production.

(7) The government will preferentially purchase raw materials, parts and components, and system and subsystem assembles needed by the defense industry from domestic sources, regularly hold public demonstrations and explanatory meetings concerning the release of contracts, expand the

release of defense contracts, increase supply niches, and provide contractors more opportunities to participate in defense technology development.

(8) Research on the international transport, information, electronics, and communications defense industry and preparatory tasks, including:

a. Use of key retired high-tech personnel from domestic and foreign industry, academia, and research organizations to help build a defensive weapon industry benefiting the country economically.

b. Establishing world-class flagship companies specializing in information, electronics, and communications with funding from the industrial cooperation budget. Together with their suppliers, these companies will form an integrated defense industry. Taiwan must develop its own version of SAIC, and thereby build a defense technology industry that is truly able to expand beyond Taiwan.

(9) Specific methods of promoting dual-use technology:

a. Effectively using the platform of the "Defense Technology Development Commission" and "Defense Industry Development Fund" to integrate dual-use technology resources, create business opportunities, and expand the dual use industry.

b. The country's defense R&D strategy must consider costs and be market oriented. Core competences should gradually be transferred to private enterprises with global ambitions. Since the private sector already possesses R&D and manufacturing capabilities, the military should not make redundant investments in similar capabilities. The government should strengthen relevant linkage and resource sharing between government agencies in order to integrate capabilities, information, knowledge, and experience, and make the most of this opportunity for military-civilian cooperation. In light of the fact that defense funding has recently been falling, the government must transform its past mindset of releasing defense technology to the private sector to a new outlook of "utilizing the strengths and resources of private industry in defense weapons and equipment," and thereby accelerate the establishment of a defense industry system.

Chapter 5 S&T Development at Government Agencies

Individual government agencies are in charge of formulating their own departmental S&T goals and strategies in accordance with their organizational missions and the S&T development strategies and visions summarized above. These agencies are also responsible for performing implementation on the basis of their resource utilization plans. See Table 1 for the planned funding to be allotted to S&T development by 17 government agencies over the period of 2005~2008; the goals and strategies of individual agencies are described in the Appendix.

Table 1 Government Agency S&T Funding Plans, 2005~2008

Units: NT$1 million

Agency	2005	2006	2007	2008	Total
AS	7,402	8,189	9,007	9,726	34,324
STAG	:	:	:	:	:
MOI	232	348	1,048	1,069	2,697
MND	:	:	:	:	:
MOE	782	978	1,223	1,527	4,510
MOEA	22,848	31,206	36,094	40,684	130,832
MOTC	693	985	1,019	1,157	3,854
DOH	3,389	3,728	4,100	4,511	15,728
EPA	78	135	148	163	524
AEC	791	1,127	1,225	1,321	4,464
NSC	30,112	34,357	37,793	41,572	152,370
COA	3,707	4,831	5,313	5,845	19,696
CLA	171	251	301	361	1,084
PCC	35	46	44	0	125
NPM	107	133	36	0	276
AH and subordinate TH	35	81	80	80	276
FSC	3	5	0	0	8

Notes: 1. "**:**" indicates no data.

2. Figures for 2005 are statutory budget numbers; figures for 2006 to 2008 are estimates.

Chapter 6 S&T Projects in Various Fields of Science and Technology

All government agencies must submit their S&T projects and the mid-term S&T plans they have drawn up to the NSC for review and deliberation in accordance with the Central Government General Budget Compilation Regulations. The mid-term S&T plans submitted to the NSC for review by the various agencies are classified under 37 fields. The review process focuses on the following five aspects: (1) feasibility of new projects; (2) performance of ongoing projects; (3) complementarity of up-, mid-, and downstream projects; (4) avoidance of redundancy; and (5) relative priority of queued projects.

The 2005 S&T funding proposal was passed by the NSC's 165th council meeting; 16 agencies submitted 248 S&T projects for review. The Executive Yuan approved funding of NT$69.617 billion, which the Legislative Yuan later trimmed to NT$63.018 billion after deliberation (Table 2).

The NSC's strategy for planning projects in the various S&T fields consists of assessing the level of research efforts in each field over the coming four years, formulating forward-looking key research items and development strategies for each field, and drafting and recommending forward-looking S&T development items and project integration mechanisms for each field as a reference for future resource allocation decisions. This process also involves the holding of field strategy planning conferences for key fields once every two years.

Detailed information on the strategy plans that have already been drafted for 27 S&T fields, and for academic research, the Challenge 2008: National Development Plan and national science and technology programs is included in the Appendix.

Table 2 Deliberation Results for S&T Projects in Individual Fields

Units: NT$100 million

Field	2003 statutory budget number	2004 statutory budget number	2005 statutory budget number	Growth rate
01. Electronics	17.57	21.83	9.86	-54.82%
02. Information	5.86	11.01	10.21	-7.30%
03. Telecommunications	0.61	0.75	00.2	-96.80%
04. Automation	3.77	4.03	3.98	-1.08%
05. Machinery	8.93	8.60	6.90	-19.80%
06. Aerospace	26.11	25.03	26.11	4.30%
07. Optoelectronics	4.22	4.67	12.79	173.74%
08. Materials	9.78	8.29	5.69	-31.40%
09. Chemical engineering	2.88	2.15	2.13	-1.02%
10. Environmental protection	6.84	8.44	7.54	-10.73%
11. Textiles	6.59	6.44	6.72	4.43%
12. Resources	1.49	1.63	1.42	-13.06%
13. Energy	0.53	0.54	0.39	-27.64%
14. Atomic energy	5.86	5.95	6.03	1.31%
15. Civil engineering	2.75	3.30	4.43	34.10%
16. Transportation	7.99	7.64	5.20	-31.99%
17. Life science and biotechnology	13.94	11.21	10.36	-7.59%
18. Foods	3.75	3.78	4.36	15.33%
19. Medicine	18.29	20.00	21.23	6.11%
20. Pharmaceuticals	3.93	4.92	4.96	0.93%
21. Agriculture	11.78	12.15	13.04	7.26%
22. Forestry	3.46	1.78	1.81	1.80%
23. Fisheries	2.56	2.58	2.97	15.20%
24. Livestock	4.29	5.07	4.52	-10.87%
26. Physics	9.53	9.98	--	-100.00% (*)
27. Chemistry	0.27	0.27	0.33	25.89%
28. Meteorology	2.51	2.68	2.65	-1.02%
29. Humanities and social sciences	0.46	0.42	0.37	-12.80%
30. Science education	7.27	7.48	10.46	39.85%
3A. Common areas-information services	13.54	14.40	14.27	-0.91%
3B. Common areas-management and guidance	56.80	62.04	66.59	7.34%
3C. Common areas-work safety	6.73	6.74	0.64	-90.45% (**)
32. Oceanography	0.61	0.63	0.64	0.70%
33. Earth science	2.07	3.08	3.68	19.71%
34. Computer networks	9.96	10.23	9.77	-4.47%
35. Ecological working methods and biodiversity	:	2.88	4.86	68.67%
36. Environmental development	11.52	13.35	29.20	118.76%
37. Service industry	:	:	1.15	New
38. National programs	122.14	127.52	117.57	-7.80%
39. Science and Technology Development Fund	5.47	1.32	19.74	1400.07% (***)
40. NSC non-field projects	136.03	160.91	175.61	9.13%
Total	558.68	605.71	630.18	4.04%

Notes: 1. *: Synchrotron Radiation Research Center projects have been transferred to the field of environmental development.

2. **: Precision Instrument Development Center and Bureau of Standards, Metrology and Inspection standards laboratory projects have been transferred to the field of environmental development.

3. ***: includes additional NT$1.3 billion.

4. ": " no data.

Chapter 7 Implementation and Control

This plan calls for the implementation of six major strategies and 185 key measures by 24 agencies to promote the country's overall S&T development. The responsible agencies shall draft implementation plans for each of the key measures and submit key annual tasks and specific indicators for the implementation plans. As for agencies' own S&T development efforts and projects in individual fields, each agency shall draft its own S&T goals, strategies, and funding plans for the coming four years, and shall implement its own plans.

The NSC is responsible for the control of this plan. The included measures may be controlled by either the Executive Yuan or the responsible agency. Implementation reports (consisting of 28 items) must be submitted every half-year for Executive Yuan-controlled measures, while implementation reports (consisting of 157 items) must be submit every year for agency-controlled measures. The NSC shall submit its control views and coordinate review by relevant agencies, and shall make a summary report to the Executive Yuan on an annual basis.

The responsible and assisting agencies for each strategy's key measures, and the control approach, are listed in this plan's "Responsibility for Key Measures and Control" section. Here the agency listed first among the responsible agencies is the first responsible agency; the first responsible agency may convene the responsible and assisting agencies for discussion of integration and coordination tasks when necessary during the implementation period.

Measures controlled under other Executive Yuan plans (or programs) shall be listed for control under the original plans. However, to maintain the integrity of this plan, implementation plans and annual implementation reports shall still be controlled under this plan.