Abstract of National Science and Technology Development Plan

(Fy2001~Fy2004)

I. Introduction

The intent behind the drafting of a national science and technology development plan is to guide the country's entrance into the knowledge economy age. Its overall goals include strengthening the knowledge innovation system, boosting industry's competitive advantage, improving citizens' quality of life, promoting sustainable development, improving nationwide technological standards, and reinforcing the country's autonomous defense capability. In other words, it is sought to bring the country into the knowledge economy age through the application of technology, improve the country's international competitiveness, and transform Taiwan into a Green Silicon Island.

As the time of the knowledge economy approaches, the world's nations face three major challenges: (1) The globalization of trade has made it harder for nations to use tangible or intangible trade barriers to protect domestic industry, knowledge, and technological innovation. (2) Despite the growing importance of environmental and ecological protection, human activities and population growth are placing an increasing burden on supplies of energy, water, and foodstuffs, while creating more pollution. How to devise sustainable development strategies that will maintain the ecological balance while fostering development has become a national development challenge. (3) The accelerating emergence of an information society and breakthroughs in the life sciences are having tremendous impacts on the activities of businesses and government, and on the way people live, study, and work. In the world of tomorrow, the importance of national boundaries will fade, creating a global village, and a new culture will emerge.

Technological development will assuredly play a key role in facing the above challenges. Technology is a critical driving force behind industrial innovation, and success in competition depends upon the sustained growth of R&D spending, which allows one to develop and introduce products and technology faster than one's competitors. And since technological

knowledge is the basis for rational decision-making, the drafting of public policy in a pluralistic society should be based on scientific information.

Having woken up to the importance of technology, the world's nations are actively bringing their technological policies in line with the new realities. The following important trends should be noted: (1) Individual government departments are increasingly promoting technology R&D, expanding participation of industry/government/universities/research institutions in the formulation of technology development policies, emphasizing forward-looking technology development planning, and implementing targeted development so as to integrate technological resources. (2) More emphasis is being placed on conducting basic science research and using the manpower of universities and research institutions to make scientific and technological breakthroughs and train the next generation of technical personnel. (3) Increasing importance is being placed on the protection and utilization of IPR as a means of safeguarding R&D results and the competitiveness of high-tech industries. (4) The rise of international cooperation and division of labor is ushering in a knowledge economy age marked by simultaneous cooperation and competition. (5) Many of the newly-industrialized nations of Asia, including Korea, China, Singapore, and Malaysia, have vigorously implemented government-backed high-tech development plans.

Among the obvious changes in Taiwan's technology development environment that have occurred over the past four years are the following: (1) The completion and enactment of the "The Fundamental Science and Technology Act" has laid out fundamental principles and directions for the country's technological development, while providing for sustained, balanced support for R&D. (2) The implementation of national-level projects addressing major socioeconomic problems has integrated limited domestic technological resources. (3)While the country's overall R&D funding reached 2.05% of GDP in 1999, this is still some distance from the goal of 2.5% originally set for 2000. (4) As for papers resulting from academic research, over the last five years Taiwan has ranked 19th in terms of the number of academic papers cited in *SCI* and 11th in terms of the number of papers cited in *EI*. There is still much work to be done, however, before Taiwan's contribution is on a par with that of the most advanced nations. (5) The government's recently-implemented "University Academic

Excellence Development Plan" seeks to concentrate funding and improve the quality of academic research by fostering outstanding research teams. (6) With regard to the development of industrial technology and high-tech industries, statistics from the US patent office (USPTO) indicate that Taiwan's rank in terms of number of approved US patents has climbed from 7th in 1996 to 4th in 1999. In terms of output value, Taiwan possesses the world's third largest computer industry and fourth largest semiconductor industry. Furthermore, the government is providing major assistance to private R&D projects in an effort to improve corporate competitiveness, is continuing to support pioneering technology R&D at research institutions, and is encouraging universities and colleges to conduct industry-university co-op research on industrial technology. These measures are laying the groundwork for sustained growth and prosperity. (7) As far as the high-tech development environment is concerned, high-tech firms in the country's Science-Based Industrial Parks have come to account for one-tenth of the country's overall industrial output over the past ten years. The success of the Hsinchu Science-Based Industrial Park has aroused the world's envy, spurring the government to develop new sites in Chunan and Tungluo, while completing development of the Tainan Science-Based Industrial Park as a center for high-tech industry in southern Taiwan. Government research on potential industrial resources in central Taiwan will serve as a basis for the selection of a new Science-Based Industrial Park site. (8) With regard to international technological interchange and cross-straits technology exchanges, cooperation in Japan's SPring-8 synchrotron accelerator program has given Taiwan exclusive use of two beamlines; links with the high-speed research network developed by America's NSF has provided the academic community with a dedicated network for cooperative international research; domestic researchers are also participating in America's cooperative astronomical observation program. As for exchanges with China, Chinese technical personnel are now allowed into Taiwan for visits, participation in research, or attendance at international conferences. Domestic researchers who wish to perform short-term research in China may apply for funding, and restrictions on the residence terms and activities of Chinese technical personnel in Taiwan have been eased. These reforms have laid a foundation for the expansion of cross-straits technological exchanges.

Although the country's technological development has made great strides, the tech sector and ordinary citizens have even greater needs and

expectations, including: (1) the training, recruitment, and utilization of creative talent; (2) the promotion of knowledge innovation and academic excellence as a means of contributing to human knowledge and creating first-rate research universities; (3) technological innovation and industrial upgrading to revitalize Taiwan's economic miracle; and (4) the realization of sustainable development and public well-being through a balanced approach to technology, ecological conservation, and the development of society and the humanities.

II. A Vision for the Nation's Technological Development

Within the next ten years Taiwan's level of technological development will reach the standard of a developed nation.

(1) Funding and manpower committed to technology will reach developed-nation levels:

1. Overall R&D funding will reach 3% of GDP by 2010.
2. Research personnel (university or above) will constitute 45 out of each 10,000 persons in the general population.

(2) Academic research:

1. Taiwan will establish a world-class academic environment over the next ten years, nurture accomplished research personnel capable of making major contributions to their fields, and achieve international academic recognition.
2. With internationally-prominent universities and research institutions, Taiwan will become an important source of knowledge and technological innovation, and will serve as a center of academic research in the Asia-Pacific region.

(3) Industrial technology:

1. The continued development of existing high-tech industries, as well as the growth of new industries based on advanced technology, will drive the country's overall industrial transformation and upgrading.
2. Within the next decade the output of the country's knowledge-intensive industries will account for 60% or more of the GDP.
3. Taiwan's technology exports will increase steadily, reaching a balanced with technology imports within the next ten years.

4. Taiwan will become an Asia-Pacific high-tech industry R&D, manufacturing, and service center.

(4) Technological development will effect a major improvement in health, housing, transportation, and environmental quality. The implementation of focused technological projects will minimize loss of life and property damage due to natural disasters such as typhoons and earthquakes.

(5) There will be a widespread improvement in citizens' technical knowledge and cultural attainment. Citizens will become more proficient at grasping new technology and using new high-tech products.

(6) Science-based industrial parks will be established in appropriate areas of the country, stimulating the emergence of high-tech industry clusters and "cities of science and the humanities" with R&D, production, ecological, and lifestyle attractions. The cities of science and the humanities will be linked to each other by high-speed computer networks and convenient transportation, creating the framework of an island of science and the humanities.

III. Strategies and Key Measures

The following eight strategies and associated measures have been drafted as a means of achieving the country's technology development goals:

Strategy 1 Strengthening the training, recruiting, and utilization of technological manpower:

Key measures:

(1) The following mid-/long-term goals have been drawn up for the development of the country's technological manpower: Mid-term goals to 2004: The number of research personnel with at least a university degree will increase to 80,000 persons, and at least 60% of these personnel will hold an M.S. or Ph.D. degree. Long-term goals to 2010: The number of research personnel with at least a university degree will increase to 100,000 persons, and at least 65% of these personnel will hold an M.S. or Ph.D. degree.

(2) More attention will be paid to training technical manpower possessing creative ability. The training of innovators and specialists in major technological areas will be strengthened.

(3) Information and network technology education will be improved.

(4) A flexible technological manpower system will be established to facilitate the training, recruiting, and utilization of technical personnel.

Strategy 2 Making the fullest and most effective use of technological funding:
Key measures:
(1) The following mid-/long-term goals have been drawn up for the nation's technology funding development: Mid-term goals to 2004: Overall R&D funding will constitute 2.3% of GDP; basic research will account for 12% of all R&D funding, while manufacturing R&D will account for 1.5% of turnover. Long-term goals to 2010: Overall R&D funding will constitute 3.0% of GDP; basic research will account for 15% of all R&D funding, while manufacturing R&D will account for 2.5% of turnover.
(2) An increased investment will be made in technology. A target of 12% annual growth in the government's technology budget has been set. More encouragement will be given to private R&D, bringing the ratio between private and public R&D funding to 7:3.
(3) Technological resources will be used as effectively as possible. The establishment of technology knowledge bases and technology policy research centers will be encouraged. Assessments of the effectiveness of technological projects and research institutions will be strengthened, and methods of improving the country's technology infrastructure will be reviewed. Purchasing criteria conforming to the country's technology and R&D characteristics will be drawn up.

Strategy 3 Strengthening academic research, pursuing academic excellence:
Key measures:
(1) An increased effort will be made to integrate resources, encourage interdisciplinary integrated research projects, and implement cutting-edge research. Areas of academic excellence will be fostered, some research universities will be raised to the best international standards, major research facilities will be established, and innovative R&D promoted.
(2) Knowledge innovation will serve as a driving force of economic development. Cooperative research involving industry and the academic community will be actively promoted, the management and application of R&D results from research institutions will be strengthened, and an IPR management and utilization system established.

Strategy 4 Strengthening technological innovation, promoting industrial upgrading:

Key measures:

(1) Industrial development focal points have been drawn up as a means of utilizing technological resources in the most effective manner. Taking a knowledge economy and environmental sustainability as goals, and assuming that research will continue to generate new technology and IPR, a number of key technological areas will be selected with the aim of improving citizens' welfare and making a maximal contribution to the economy. These areas will be in the fields of computers and software technology, telecommunications system technology, micro-electromechanical technology, precision machinery, aerospace technology, energy and environmental technology, advanced materials and chemical technology, and life science and biomedical technology. Integrated, focused, systematic research will be conducted in the selected areas in hopes of making scientific and technological breakthroughs.

(2) Technological innovations strategies will be implemented to expedite the transition to a knowledge economy. Funding for innovative R&D will be increased over successive years, and industry-based technology research consortiums organized. Professionally-oriented planning and execution systems will be established.

(3) The promotion of interdisciplinary industrial technology research and inter-organizational or international R&D will strengthen the quality and efficiency of research work, and improve industrial competitiveness.

(4) The development and creation of science-based industrial parks will be strengthened, the scope of industry clusters expanded, and more globalization assistance and industrial information services given to businesses. The size and type of future science-based industrial parks will conform to local conditions, and the site selection process will take into consideration the conservation of natural resources and the utilization of regional socioeconomic advantages.

Strategy 5 Improving public welfare and environmental quality:

Key measures:

(1) With regard to environmental protection, the "Nationwide Industrial Waste Control and Disposal Program" has been enacted, clean production technology has been promoted, and drinking water

conservation measures implemented. A greenhouse gas emission reduction strategy has been devised in light of the possible impact of global changes.

(2) In the area of disaster-mitigation technology, greater effort will be made to apply and utilize disaster-mitigation technology R&D results. More R&D work will be conducted on the socioeconomic aspects of disaster prevention technology. Research on reconstruction following great earthquake of 1999 will be strengthened, and a disaster prevention and relief technology center established.

(3) In the area of water and marine resource technology, comprehensive data on water/marine resources will be collected, research performed on ratios for the allocation of agricultural, industrial, residential water, alternative water supplies studied, and water distribution and recycling technology developed. R&D efforts will pay appropriate attention to ecological conservation, environmental regulation, and the development of aquatic biological resources, as well as on water management and sustainable use technologies.

(4) In the area of energy technology, increased research attention will be paid to new and recycled energy sources, and new energy utilization and conservation technologies. Directions and strategies for domestic fuel cell research will be drawn up, clean coal burning technology acquired and promoted, and compulsory energy efficiency management continued. The development of energy-saving technologies will be accelerated.

(5) E-government will be promoted and convenient government services made available over the Internet. Online public opinion forums will be established. Information age civil servants will be trained in a customer-oriented service outlook.

(6) In the area of medical and public health technology, a management and inspection system for genetically-improved foods will be set up. A biological information resources center and genetic/medical databases will be established. The government will promote the development of a biological information software/hardware industry, established a national genome research system, and formulate appropriate guiding principles for genetic medicine.

(7) In the area of agricultural technology, standards will be drawn up for the management of transgenic animal/plant field trials. Research will be performed on the possible environmental impact of transgenic animal/plants and impact assessment technologies. Remote sensing

technology will be used to establish a drought/flood warning system and a coastal flooding and fisheries resources monitoring system. Fast disease/pest detection technologies, animal/plant disease warning systems, disease notification systems, and pathogen and disease resistance gene bases will be developed.

(8) In the area of transportation technology, intelligent transportation systems (ITS) will be developed, the basic infrastructure for ITS deployed, and a national transportation technology certification organization and testing environment established. A national-level transportation infrastructure and management information system will be created.

(9) In construction technology, active efforts will be made to institute green construction technologies and building energy conservation. A construction resources recycling and reuse system will be established, construction waste reduction and reuse indicators will be formulated, and public construction monitoring and resource integration and utilization mechanisms instituted.

(10) In the area of peaceful nuclear technology, a greater effort will be made to create the infrastructure for the medical application of nuclear technology, including stepped-up attention to manpower training, international cooperation, and R&D resource planning. An Asia-Pacific medical isotope and nuclear medicine R&D and manufacturing center will be planned and implemented, and applications of nuclear technology in industrial development and medical treatment will be strengthened.

Strategy 6 Promoting the mutual development of technology and a humane society:

Key measures:

(1) Information technology will be used to establish a superior humanities research environment. Relevant laws governing public information will be drafted, the public right to obtain information protected, and a national digital collection and digital museum planned and implemented.

(2) Increased attention will be paid to the ethical, legal, and social implications of new technology. An active effort will be made to draft laws and ethical guidelines governing biotechnology and information technology.

(3) Beneficial interaction between the Internet and society will be fostered.

(4) Research will be conducted on "risk consciousness" in technological society.

Strategy 7 Implementing nationwide technology education and improving citizens' technical knowledge:
Key measures:
(1) Technology education for citizens will be strengthened, and elementary/junior high school science improved.
(2) The dissemination of new technological knowledge will be promoted.
(3) Popular science reading activities will be held.
(4) Indicators will be established to gauge citizens' technological attainments. Methods will be devised to foster scientific thinking and awareness among the public.

Strategy 8 Establishing an autonomous defense technology industry and R&D system:
Key measures:
(1) An expert assessment committee will be established to evaluate the prospects of defense technology and the defense industry.
(2) The R&D capabilities of industry, universities, and research institutions will be used to integrate defense resources and create a national defense technology system.
(3) Laws will be drafted to govern cooperation between defense technology firms/organizations and private parties in an effort to foster a robust private defense industry. Mechanisms governing military/civil dual-use enterprises will be strengthened, establishing an autonomous defense system.
(4) An armaments organization and a military equipment selection system will be established. Mechanisms for the sale of defense technology industry products will be put in place.
(5) The organization of the Chung Shan Institute of Science and Technology will be overhauled and research units transformed into non-profit organizations.