
# 2010 National Science Council Review


# National Science Council

2010

# Foreword

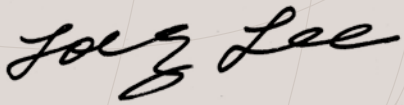
Thanks to much hard work on the part of all our colleagues, beyond continuing to implement the nation's overall scientific and technological development, support academic research, and cultivate the science parks, the NSC also maintained its consistently-high morale, revised numerous laws and regulations to stay up with the times, and adopted many innovative methods as a response to future development needs.

Drafted by government agencies convened by the NSC, the *ROC White Paper on Science and Technology (2011-2014)* formulates eight development strategies addressing such aspects as academic research, the economy, human welfare, and the environment, and seeks to achieve the vision of transforming Taiwan into a "innovative global pioneer in green energy technology and intelligent living" by 2020. After receiving the Executive Yuan's approval in December 2010, the NSC will strengthen coordination and integration, use the country's limited S&T resources to achieve the greatest results, and attain the objectives set forth in the White Paper.

The Executive Yuan has embarked on organizational re-engineering work in order to streamline the government's organization and rise to the challenges of globalization. The revised *Organic Act of the Executive Yuan* announced by the President in February 2010 merges the NSC with the National Science and Technology Center for Disaster Reduction and the Atomic Energy Council's nuclear safety control mission, establishing the Ministry of Science and Technology, which will bear responsibility for promotion of scientific and technological development, mid-stream basic academic research, and applied research. Accordingly, in line with the principles of "streamlining, flexibility, and performance," the NSC and other relevant agencies wrote draft organic acts for the Ministry of Science and Technology; Nuclear Safety Agency, Ministry of Science and Technology; Northern Taiwan Science Park Administration, Ministry of Science and Technology; Central Taiwan Science Park Administration, Ministry of Science and Technology; and Southern Taiwan Science Park Administration, Ministry of Science and Technology, as well as the *Act Governing the Establishment of the National Science and Technology Center for Disaster Reduction.* After having been passed by the Executive Yuan conference in January 2011, these bills are currently being deliberated by the Legislative Yuan. Following the establishment of the Ministry of Science and Technology, Taiwan's scientific and technological development work will proceed even more effectively.

In addition, the *NSC Review* has always been published in printed form since 1963, and has had both printed and online versions since 1997. In view of the ubiquity of the Internet and widespread use of electronic devices to browse or download information at any time or place, the NSC has decided to issue only an online version of the *Review* starting this year (2010) in order to conserve energy, reduce carbon emissions, and lessen the need for hard-copy storage space. After the annual publication of the *Review*, the NSC will notify agencies and subscribers to make use of it online.

NSC Minister



National Science Council

NSC

# Contents


Foreword

**Chapter 1 Overview**

I. Science and Technology Development Policies 5
II. Funding 7
III. Organizational Reengineering 10

**Chapter 2 Promoting Nationwide Scientific and Technological Development**

I. Nationwide R&D Funding 13
II. National R&D Manpower 14
III. Science and Technology Research Results 15

**Chapter 3 Support for Academic Research**

I. Support for Specific-topic Research Projects 18
II. R&D Achievements in Individual Disciplines 21
A. General Specific-topic Research Projects 21
1. Natural Science 21
2. Engineering 24
3. Life Science 28
4. Humanities and Social Sciences 31
5. Science Education 34
B. Industry-Academic Collaborative Research Projects 39
C. National-Level Science and Technology Programs 40
1. Networked Communication Program 40
2. National Science and Technology Program for Systems-on-Chip 42
3. National Science and Technology Program for Nanoscience and Nanotechnology 45



4. National Science Technology Program-Energy 46

5. National Science and Technology Program for Biotechnology and Pharmaceuticals 48

6. National Research Program for Genomic Medicine 50

7. Taiwan e-Learning and Digital Archives Program 52

D. Research Results of the National Synchrotron Radiation Research Center 56

E. Research Results of the National Applied Research Laboratories 57

III. Manpower Recruiting and Training 70

IV. Research Awards 72

V. International Cooperation in Science and Technology 74

VI. S&T Interchange with China 77

VII. Improving the Research and Development Environment 78

A. Online Services 78

B. Centralized Use of Major Instruments 79

VIII. Management and Extension of Research Results 80

IX. Increasing Citizens' S&T Knowledge 81

X. Publications 83

**Chapter 4 Development of Science Parks**

I. Hsinchu Science Park 85

II. Southern Taiwan Science Park 87

III. Central Taiwan Science Park 89


# Contents

Chapter 1

# Overview

Science and Technology Development Policies

Funding

Organizational Reengineering

# I. Science and Technology Development Policies

## A. State of S&T Development and Current trends

In recent years, the rapid advance of science and technology and the snowballing trend toward globalization have posed major threats to humanity. The US subprime loan crisis triggered a global recession, dangerous new strains of flu have emerged and spread rapidly, overdevelopment has caused environmental changes, resources are swiftly being exhausted, and the natural ecology is dangerously out of balance. Because these and other crises affect all of the world's countries, the promotion of international cooperation must form an indispensable part of national development policies.

Apart from common international issues, Taiwan also faces challenges of its own: a lack of natural resources, limited living space, a fragile natural environment, disputes over whether economic development should take precedence over quality of life and safety, the influence of expanding contact with China on Taiwan's industrial development, and aging society and trend toward smaller families. These issues are inevitably having a significant impact on Taiwan's long-term development and training of human resources. Through constant investigation and discussion of these issues by industry, government, academia, and the research community, the formation of relevant policies is accelerating, and it is expected that Taiwan can achieve a new model of intelligent living and a new period of economic growth, allowing the country to maintain its advantageous role in global technological innovation networks.

According to the Lausanne International Institute for Management Development's (IMD) *2010 World Competitiveness Report*, Taiwan ranked 8th among 58 economies—a jump of 15 places compared with 2009—and ranked 5th in the categories of "scientific development" and "technological development"—which represented gains of three and six places respectively compared with 2009. Taiwan also maintained its dominant positions in the science- and technology-related indicators of "technological development," "scientific development," and "Innovation," revealing Taiwan's sustained development of science and technology, and ceaseless pursuit of innovation in an effort to maintain technological competitiveness.

## B. Taiwan's S&T Development Vision and Strategies

The enactment of the *Fundamental Science and Technology Act* in January 1999 provided a legal basis for the development of science and technology in Taiwan. This Act prescribes that the government submit an S&T vision, strategies, and explanation of the current situation once every two years, and draft a national science and technology development plan once every four years. The Executive Yuan has accordingly drafted a national science and technology development plan every four years since 2001 to serve as a basis for the formulation of S&T policies and the promotion of research and development. However, in order to respond to the increasingly fast-paced development of science and technology, the government has begun publishing a White Paper on Science and Technology revised on a rolling basis at four-year intervals (staggered by two years from the date of the national science and technology development plan) and containing the results of discussion of the country's S&T development vision, strategies, and the current circumstances by relevant government agencies convened by the NSC. Thus far, the government has issued the 2001-2004, 2005-2008, and 2009-2012 *National Science and Technology Development Plan* and the 2003-2006, 2007-2010, and 2011-2014 *ROC White Paper on Science and Technology*.

The 2011-2014 *White Paper on Science and Technology* was approved by the Executive Yuan at its 3,226th conference on December 16, 2010. The White Paper was drafted jointly by relevant government agencies convened by the NSC; and emphasizes innovative S&T R&D, stewardship of a green sustainable environment, promotion of industrial and economic development, and improvement of citizens' well-being. The country will also continue to pursue the goals of "academic excellence in research," "innovation in industrial technology," "citizens' safety and well-being," and "a superior, sustainable environment." Apart from continuing to build on the country's outstanding information and communications technology and industrial advantages, Taiwan will also actively develop green energy and intelligent living technology, strengthen biotech medicine and disaster mitigation and response R&D, promote new service industries, emphasize dialog between S&T and the humanities, and provide citizens with a superior quality of life and living environment, transforming Taiwan into a global innovator in the areas of green energy technology and intelligent living.

Taiwan will employ eight major development strategies in the areas of academic research, economics, citizens' welfare, and the environment to achieve its S&T development vision and goals. In the area of academic research, the country will strive to train outstanding human resources in order to achieve the world's highest level of research quality and establish a place for Taiwan in global innovation networks. In the area of economic development, the country will strengthen design and innovation, form alliances between emerging intelligent industries, ensure that people's everyday needs are met, and build up the country's economic power. In the area of citizens' welfare, Taiwan will improve disaster mitigation/response and living technology, boost citizens' safety, and draw on humane technologies to develop an economy of aesthetics and enhance quality of life. With regard to environmental development, the country will establish a favorable environment facilitating the application of scientific research results, activate local resources, place appropriate emphasis on environmental conservation, and fulfill Taiwan's responsibilities as a global citizen. The eight major development strategies are as follows:

**Strategy 1 Making the best use of S&T human resources, developing boundless knowledge value**

1. Recruiting and utilizing S&T human resources

2. Responding to demographic changes by balancing the manpower supply and demand in key areas of science and technology
3. Training innovative, interdisciplinary manpower possessing global perspectives and familiarity with international systems
4. Promotion of international S&T and manpower interchange, establishing links with the international S&T community and industrial innovation networks

**Strategy 2 Emphasizing the quality of academic research, promoting cooperation between researchers and industry**

1. Establishing a superior academic research environment, boosting S&T research service performance
2. Building active, top-notch research communities, pursuing world-class research quality
3. Promoting close cooperation among industry, academia, and research organizations, establishing an intensively interactive knowledge innovation system
4. Emphasizing the assessment, application, and extension of academic research results

**Strategy 3 Establishing global innovation centers, strengthening distinctive industry clusters**

1. Systematic analysis of global market opportunities and S&T trends, establishing global resource links and an R&D deployment
2. Encouraging companies to invest in green R&D design and production, and boost their company brands and global marketing abilities
3. Developing distinctive high-added-value industry clusters, establishing high-tech industry innovation corridors
4. Making optimal use of the strengths of the information and communications industry, drawing on Taiwan's cultural creativity, becoming a global innovation center
5. Activating the utilization of intellectual property, putting the innovative start-up environment on a sound footing

**Strategy 4 Developing health and living science and technology, establishing emerging intelligent industries**

1. Promotion of key emerging industries, consolidating diversifying industrial development
2. Promoting emerging intelligent industries, fostering industrial innovation value
3. Connecting biotech industry value chains, enhancing the economic output of bioscience, promoting citizens' health and welfare
4. Developing an interdisciplinary integrated applied life industry connected with the public's needs

**Strategy 5 Integrating disaster mitigation and response science and technology, enhancing people's well-being and safety**

1. Assessing the impact of global climate change, developing natural disaster management systems
2. Strengthening disaster mitigation and response technology R&D, boosting society's overall disaster resilience and recovery ability
3. Putting environmental monitoring and risk assessment on a sound footing, developing climate change adaptation strategies
4. Activating the disaster mitigation and response system's notification, communication, and coordination functions, strengthening post-disaster recovery and reconstruction performance

**Strategy 6 Combining the humanities with science and technology, boosting intelligent soft power**

1. Drawing on S&T innovation, cultural creativity, and local life to promote art & culture industries and enhance quality of life
2. Responding to social change, developing humane technologies and emerging service industries
3. Creating an intelligent living environment, fostering a superior, contented social atmosphere

**Strategy 7 Deregulation and institutional reform, promoting forward-looking policy planning**

1. Promoting forward-looking technological research, achieving a nationwide consensus concerning the long-term development of science and technology and society
2. Emphasizing long-term planning of S&T development and performance assessment
3. Promotion of deregulation and institutional reform to create an environment promoting the development of science and technology
4. Putting the legal system on a sound footing, promoting the synergistic use of the R&D results of industry, academia, and research organizations

**Strategy 8 Developing sustainable energy technology, building a green, low-carbon environment**

1. Promotion of clean, green energy technology, creation of green jobs, promotion of a low-carbon economy
2. Enhancement of the value in traditional industries and reduction of carbon emissions, development of a green energy industry environment
3. Promotion of land restoration and environmental protection, pursuit of sustainable development
4. Development of marine science and technology, balancing conservation and utilization of marine/terrestrial resources

# II. Funding

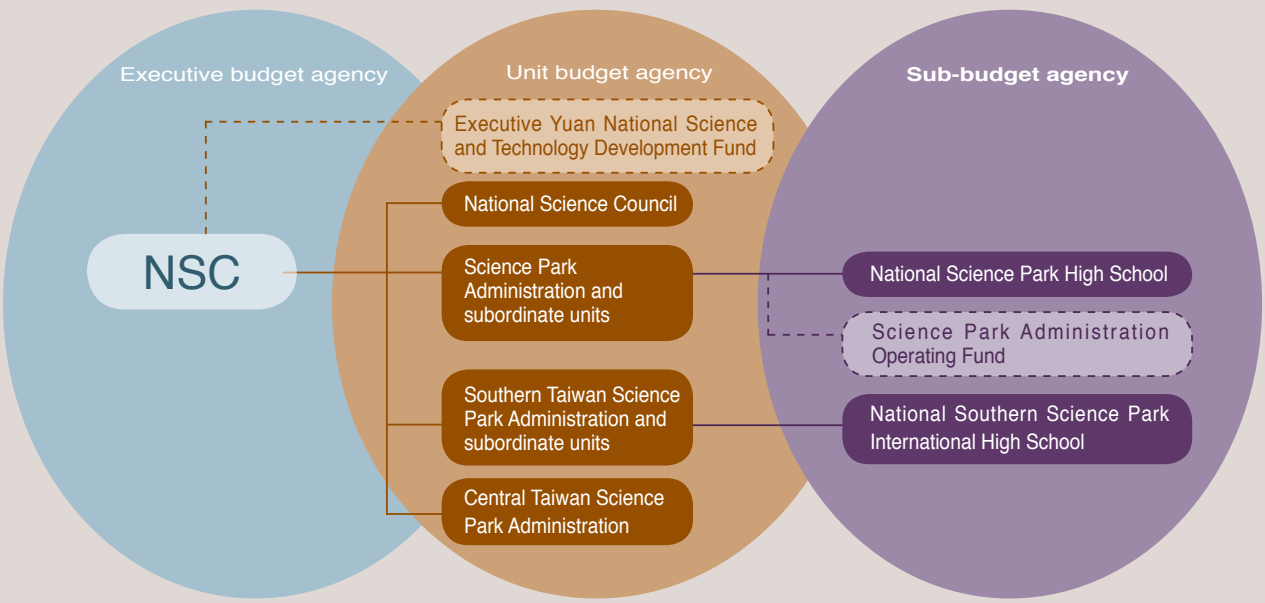
The NSC's executive budget for the year consisted of four parts corresponding to the NSC itself, the Science Park Administration and subordinate organizations, the Southern Taiwan Science Park Administration and subordinate organizations, and the Central Taiwan Science Park Administration. In addition, the budgets of the Science Park Administration and subordinate organizations and Southern Taiwan Science Park Administration and subordinate organizations also include sub-budgets for the National Science Park High School and National Southern Science Park International High School. Furthermore, the NSC is also responsible for management of the Executive Yuan National Science and Technology Development Fund, and the Science Park Administration is responsible for management of the Science Park Administration Operating Fund.

The NSC's annual income budget for 2010 was NT$155.58 million, which was a decrease of NT$28.64 million (-15.55%) over the NT$184.22 million income budget of the previous year. This budget included fine income consisting of NT$11.38 million compensation for late vendor deliveries; NT$61.28 million in fee income, which included registration and status change fees from science park companies and construction licenses; NT$32.15 million in property income, which included income from leasing of Hsinchu Biomedical Park land and rental of technology building space; and NT$50.77 million in other income including tuition and miscellaneous fees at the National Science Park High School.

The NSC's expense budget for 2010 was NT$41.733 billion, which was a decrease of NT$682 million (-1.61%) compared with the NT$42.415 billion budget of the previous year. Of this budget, the NSC budget accounted for NT$37.137 billion, and was mainly used to fund the National Synchrotron Radiation Research Center and National Applied Research Laboratories, and increase national treasury support for S&T project funding from the Science and Technology Development Fund. The Science Park Administration and subordinate organization budget was NT$1.522 billion, which was mainly used for various park services, development of the Hsinchu Biomedical Park, and for increasing national treasury support for park development project funding from the Science Park Administration Operating Fund. The Southern Taiwan Science Park Administration and subordinate organization budget was NT$1.362 billion, and was mainly used for park services and for increasing national treasury support for park development project funding and the High Speed Rail Stimulus Program from the Science Park Administration Operating Fund. The Central Taiwan Science Park Administration budget was NT$1.712 billion, and was mainly used for park services and for increasing national treasury support for park development project funding from the Science Park Administration Operating Fund.

The NSC originally established the National Science and Technology Development Fund in order to promote the long-term development of science and technology. The Fund's budget was included within the NSC's unit budget up to 1991, but was made a unit budget item in 1992. In order to increase the flexibility and timeliness of fund implementation, the Fund's budget was changed to a subordinate unit budget in 1998.

**Schematic diagram of agencies under the NSC's executive budget**




Note: Broken lines indicate subordinate unit budgets

Following the announcement of the Fundamental Science and Technology Act in 1999, the Fund was taken from the NSC and put under the Executive Yuan's oversight, but the NSC retained its status as the fund management agency. The 2003 revision of the Fundamental Science and Technology Act specifies that the National Science and Technology Development Fund budget should be a subordinate unit budget.

The National Science and Technology Development Fund received NT$31.231 billion in R&D results income and appropriations from the national treasury in 2010. The Fund provided NT$32.955 billion in funding for academic research throughout the year (including NT$359 million from the central government's special economic stimulus budget for expanded public construction to increase funding for the Superior Human Resources Training and Employment Promotion Program).

The NSC's final executive income figure for the year was NT$149.46 million, which represented a reduction of NT$6.12 million over the budget number. This decrease can mainly be attributed to less-than-expected income due to a drop in registration and status change fees from science park companies caused by the global financial crisis and recession.

The NSC's final executive expenditure figure for 2010 was NT$41.434 billion, which represented a decrease of NT$299 million compared with the budget number. This decrease was mainly due to the NSC's contribution of funding to the National Synchrotron Radiation Research Center and National

**Annual NSC Executive Income Budgets, 2006-2010** **Units: NT$1 m**

| Item | 2006 | | 2007 | | 2008 | | 2009 | | 2010 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Amount | Increase (%) | Amount | Increase (%) | Amount | Increase (%) | Amount | Increase (%) | Amount | Increase (%) |
| Fines and compensation income | 4.45 | 56.69 | 2.94 | -33.93 | 2.89 | -1.70 | 11.56 | 300.00 | 11.38 | -1.56 |
| Fee income | 46.37 | -28.88 | 40.09 | -13.54 | 46.06 | 14.89 | 62.39 | 35.45 | 61.28 | -1.78 |
| Property income | 10.12 | 5.86 | 16.31 | 61.17 | 30.88 | 89.33 | 60.78 | 96.83 | 32.15 | -47.10 |
| Other income | 28.79 | 4.27 | 29.67 | 3.06 | 33.89 | 14.22 | 49.49 | 46.03 | 50.77 | 2.59 |
| **Total** | 89.73 | -14.71 | 89.01 | -0.80 | 113.72 | 27.76 | 184.22 | 61.99 | 155.58 | -15.55 |

**Annual NSC Executive Expenditure Budgets, 2006-2010** **Units: NT$100 m**

| Item | 2006 | | 2007 | | 2008 | | 2009 | | 2010 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Amount | Increase (%) | Amount | Increase (%) | Amount | Increase (%) | Amount | Increase (%) | Amount | Increase (%) |
| NSC | 340.17 | 4.79 | 367.08 | 7.91 | 357.56 | -2.59 | 358.95 | 0.39 | 371.37 | 3.46 |
| Science Park Administration and subordinate organizations | 39.40 | -30.69 | 41.17 | 4.49 | 15.10 | -63.32 | 24.51 | 62.32 | 15.22 | -37.90 |
| Southern Taiwan Science Park Administration and subordinate organizations | 25.23 | -38.46 | 13.51 | -46.45 | 19.06 | 41.08 | 31.87 | 67.21 | 13.62 | -57.26 |
| Central Taiwan Science Park Administration | | | | | 22.09 | | 8.82 | -60.07 | 17.12 | 94.10 |
| **Total** | 404.80 | -4.18 | 421.76 | 4.19 | 413.81 | -1.88 | 424.15 | 2.50 | 417.33 | -1.61 |

**National Science and Technology Development Fund Budget, 2006-2010** **Units: NT$100 m**

| Item | 2006 | | 2007 | | 2008 | | 2009 | | 2010 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Amount | Increase (%) | Amount | Increase (%) | Amount | Increase (%) | Amount | Increase (%) | Amount | Increase (%) |
| Fund sources | 254.18 | 5.71 | 288.56 | 13.53 | 288.48 | -0.03 | 296.52 | 2.79 | 312.31 | 5.33 |
| Government appropriations | 243.15 | 7.09 | 275.79 | 13.42 | 276.43 | 0.23 | 283.52 | 2.56 | 298.00 | 5.11 |
| Other[1] | 11.03 | -17.56 | 12.77 | 15.78 | 12.05 | -5.64 | 13.00 | 7.88 | 14.31 | 10.08 |
| Fund uses | 267.97 | 12.05 | 288.55 | 7.68 | 302.84 | 4.95 | 314.24 | 3.76 | 329.55 | 4.87 |
| Development promotion | 232.15 | 9.95 | 257.07 | 10.73 | 271.17 | 5.48 | 278.61 | 2.74 | 298.99 | 7.31 |
| Manpower training | 12.39 | 40.80 | 13.28 | 7.18 | 15.56 | 17.17 | 17.07 | 9.70 | 18.38 | 7.67 |
| Environment improvement | 22.89 | 22.67 | 17.69 | -22.72 | 15.58 | -11.93 | 17.98 | 15.40 | 11.61 | -35.43 |
| Administration & management | 0.54 | -1.82 | 0.51 | -5.56 | 0.53 | 3.92 | 0.58 | 9.43 | 0.57 | -1.72 |
| Surplus/shortfall for period (-) | -13.79 | | 0.01 | | -14.36 | | -17.72 | | -17.24 | |

[1] Includes royalty income, service income, miscellaneous income, and interest income, etc.

Applied Research Laboratories, surplus funds from the NSC's procurement cases and a reduction in expenditures due to favorable exchange rates, surplus funds from the leasing of the Science Park Administration's of standard biotech plant buildings, surplus personnel affairs funds, and the trimming of certain expenditures.

The Science and Technology Development Fund had a final shortfall of NT$1.191 billion at the end of 2010, which was NT$533 million less than the expected budget shortfall of NT$1.724 billion and chiefly attributable to the scheduling of projects with multi-year funding and matching funding.

**Annual NSC Final Income Figures, 2006-2010** **Units: NT$1 m**

| Item | 2006 | | 2007 | | 2008 | | 2009 | | 2010 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Final number | Change from budget number | Final number | Change from budget number | Final number | Change from budget number | Final number | Change from budget number | Final number | Change from budget number |
| Fines and compensation income | 10.84 | 6.39 | 14.79 | 11.85 | 13.73 | 10.84 | 16.18 | 4.62 | 16.35 | 4.97 |
| Fee income | 57.31 | 10.94 | 50.67 | 10.58 | 36.76 | -9.30 | 27.04 | -35.35 | 45.87 | -15.41 |
| Property income | 17.86 | 7.74 | 15.03 | -1.28 | 15.21 | -15.67 | 37.23 | -23.55 | 34.33 | 2.18 |
| Other income | 235.40 | 206.61 | 57.97 | 28.30 | 47.98 | 14.09 | 75.08 | 25.59 | 52.91 | 2.14 |
| **Total** | 321.41 | 231.68 | 138.46 | 49.45 | 113.68 | -0.04 | 155.53 | -28.69 | 149.46 | -6.12 |

**Annual NSC Executive Final Expenditure Figures, 2006-2010** **Units: NT$100 m**

| Item | 2006 | | 2007 | | 2008 | | 2009 | | 2010 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Final number | Change from budget number | Final number | Change from budget number | Final number | Change from budget number | Final number | Change from budget number | Final number | Change from budget number |
| NSC | 336.84 | -3.33 | 362.87 | -4.21 | 350.56 | -7.00 | 346.51 | -12.44 | 370.02 | -1.35 |
| Science Park Administration and subordinate organizations | 38.26 | -1.14 | 39.97 | -1.20 | 13.79 | -1.31 | 13.62 | -10.89 | 14.06 | -1.16 |
| Southern Taiwan Science Park Administration and subordinate organizations | 15.29 | -9.94 | 13.22 | -0.29 | 18.53 | -0.53 | 30.58 | -1.29 | 13.29 | -0.33 |
| Central Taiwan Science Park Administration | | | | | 21.75 | -0.34 | 7.14 | -1.68 | 16.97 | -0.15 |
| **Total** | 390.39 | -14.41 | 416.06 | -5.70 | 404.63 | -9.18 | 397.85 | -26.30 | 414.34 | -2.99 |

**Final Budget Numbers of the National Science and Technology Development Fund, 2006-2010** **Units: NT$100 m**

| Item | 2006 | | 2007 | | 2008 | | 2009 | | 2010 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Final number | Change from budget number | Final number | Change from budget number | Final number | Change from budget number | Final number | Change from budget number | Final number | Change from budget number |
| Fund sources | 256.38 | 2.20 | 290.21 | 1.65 | 290.18 | 1.70 | 313.17 | 16.65 | 315.21 | 2.90 |
| Government appropriations | 243.15 | 0.00 | 275.79 | 0.00 | 276.43 | 0.00 | 295.94 | 12.42 | 298.00 | 0 |
| Other[1] | 13.23 | 2.20 | 14.42 | 1.65 | 13.75 | 1.70 | 17.23 | 4.23 | 17.21 | 2.90 |
| Fund uses | 250.77 | -17.20 | 274.34 | -14.21 | 273.28 | -29.56 | 302.95 | -11.29 | 327.12 | -2.43 |
| Development promotion | 219.61 | -12.54 | 246.26 | -10.81 | 244.52 | -26.65 | 273.17 | -5.44 | 294.27 | -4.72 |
| Manpower training | 11.17 | -1.22 | 12.21 | -1.07 | 14.32 | -1.24 | 18.29 | 1.22 | 22.48 | 4.10 |
| Environment improvement | 19.47 | -3.42 | 15.36 | -2.33 | 13.94 | -1.64 | 10.96 | -7.02 | 9.74 | -1.87 |
| Administration & management | 0.52 | -0.02 | 0.51 | 0.00 | 0.50 | -0.03 | 0.53 | -0.05 | 0.63 | 0.06 |
| Surplus/shortfall for period | 5.61 | 19.40 | 15.87 | 15.86 | 16.90 | 31.26 | 10.22 | 27.94 | -11.91 | 5.33 |

[1] Includes royalty income, service income, miscellaneous income, and interest income, etc.

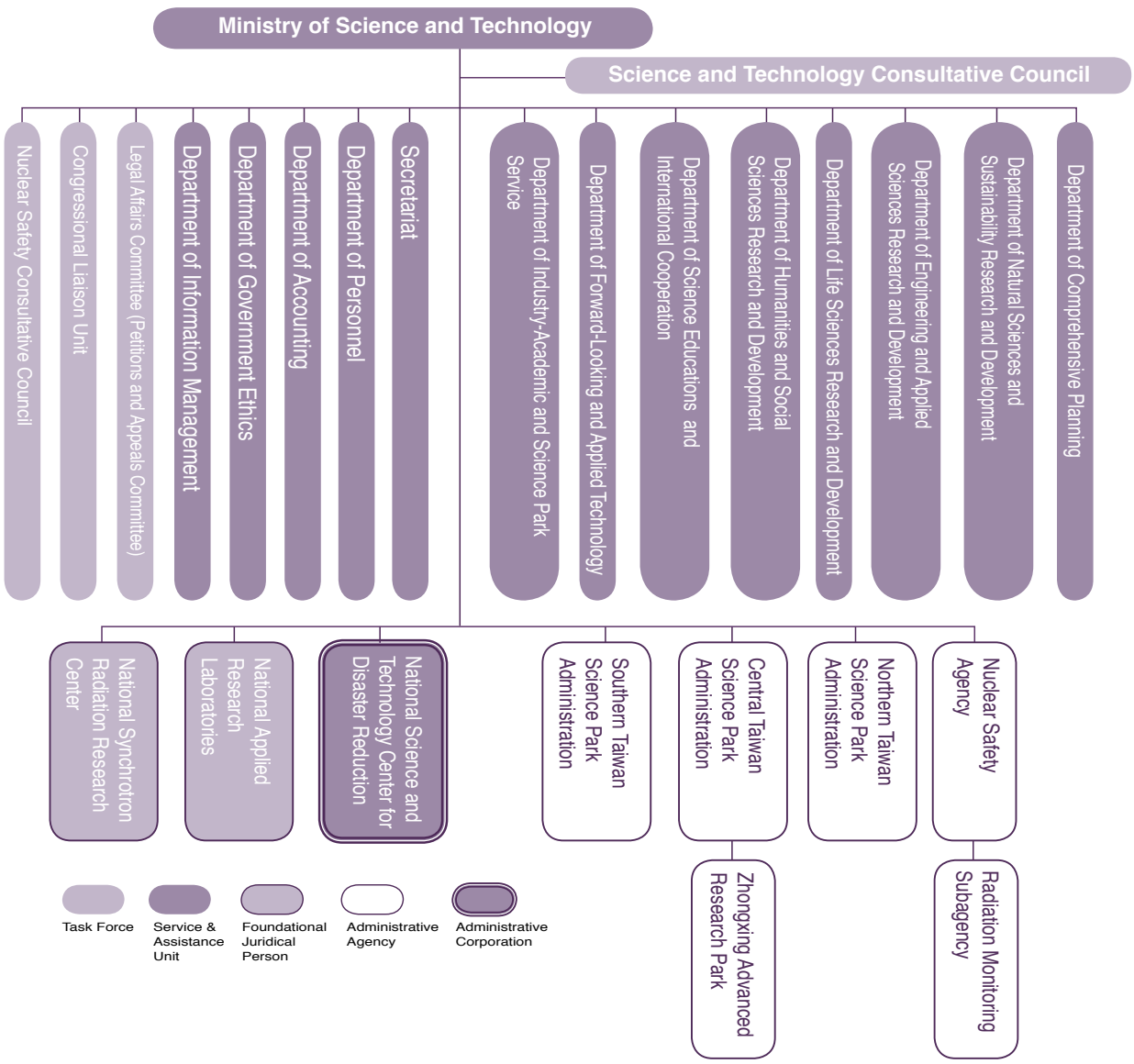
# III. Organizational Reengineering

In order to establish a lean, flexible, effective government in the face the economic pressures of globalization, Taiwan's government organizations must make both functional and structural adjustments so as to achieve a favorable position in the global economic system and succeed in the international competitive race. Because of this, organizational reengineering seeking to promote administrative efficiency and boost national competitiveness will be an important means of establishing a high-performance government organization.

The revision of the ROC's *Organic Act of the Executive Yuan* began with the establishment of a case task force by the Executive Yuan in August 1987. Since that time, there have been many changes in the external environment at large, the Constitution has been amended, the *Organic Standard Act of Central Government Agencies* has been announced, and the political party in power has changed twice. After deliberation by the Legislative Yuan in October 1988, April 2002, September 2004, February 2005, February 2008, and April 2009, the revised *Organic Act of the Executive Yuan* was finally passed by the legislature on January 12, 2010, and was publicly announced by the president on February 3 of the same year.

In accordance with the newly revised Organic Act, a "Ministry of Science and Technology" will be established, and will combine the functions of the (1) National Science Council (apart from interagency coordination functions), (2) the Atomic Energy Council, Executive Yuan (including all of the functions of the Atomic Energy Council and the functions of the Institute of Nuclear Energy Research supporting nuclear safety control

## Organization of the Ministry of Science and Technology (draft)



measures), and the (3) National Science and Technology Center for Disaster Reduction, National Disaster Prevention and Protection Commission, Executive Yuan.

In line with the principles of "lean, flexible, and effective government," the NSC and the Atomic Energy Council are currently formulating the draft organic acts of the Ministry of Science and Technology; Nuclear Safety Agency, Ministry of Science and Technology; Northern Taiwan Science Park Administration, Ministry of Science and Technology; Central Taiwan Science Park Administration, Ministry of Science and Technology; and Southern Taiwan Science Park Administration, as well as the draft *Act Governing Establishment of the National Science and Technology Center for Disaster Reduction*.

S&T development can generally be divided into up-, mid, and downstream work, which correspond to the three stages of basic (academic) research, applied research, and technology development and commercialization. The planned Ministry of Science and Technology will chiefly bear responsibility for promotion of upstream and midstream basic academic research and applied research, and other government agencies will bear responsibility for midstream and downstream technology development and commercialization. Because of this, the Ministry of Science and Technology will have the following primary missions:

1. Drafting and implementation of scientific and technological research and development policies: The Ministry of Science and Technology will emphasize research and analysis of the S&T development environment and policies, mid-/long-term S&T development surveys, the nation's S&T development vision, planning and implementation of policies and strategies, and drafting of key areas of national S&T development.
2. Support for academic research: The academic research implemented and supported by the NSC has yielded many outstanding results over the years. In the future, the Ministry of Science and Technology will further strengthen academic research and development strategies, expand and improve the research environment, promote interdisciplinary and interagency research, plan and implement work in areas of strength and innovative and pioneering fields, and enhance the utilization and extension of academic research results.
3. Promotion of major S&T research and development and applied research efforts: In order to promote top-down large-scale applied technology R&D work, including efforts bringing new industries into being, enhancing citizens' quality of life, and meeting national development needs, the government will draft research and development items conforming to national sentiments and development needs and addressing specific future-oriented issues, and establish reliable screening and focal models, such as methods of screening basic research results for findings that are worthy of application and practical use, and promotion methods. In addition, the promotion of collaboration between industry, academia, and the research community will link up-, mid-, and downstream R&D and application capabilities.
4. Strengthening international S&T cooperation: Due to the emergence of a global community, many important issues are no longer solely domestic problems, but have taken on an international character and may require the strenuous efforts of many countries to be resolved. The future Ministry of Science and Technology will consequently build on the current solid foundation by continuing to strengthen international interchange and collaboration in the areas of academic research, science parks, and nuclear safety and control. This will enhance Taiwan's international influence and make a contribution to the international community.
5. Promotion of research on sustainable development and disaster mitigation science and technology: Compared with other countries, Taiwan has a high incidence of natural disasters. The Ministry of Science and Technology will continue to implement currently scientific research on sustainability and disaster mitigation, and will compile comprehensive basic data concerning sustainable development and environmental issues in order to facilitate the planning disaster prevention and relief solutions. The government will also establish the administrative corporation National Science and Technology Center for Disaster Reduction, which will coordinate, plan, and implement disaster prevention and relief science and technology R&D matters, and support disaster mitigation S&T R&D and applications as a foundation of national sustainable development.
6. Development of science parks: The science park system currently consists of northern, central, and southern science Park administrations located in Hsinchu, Taichung, and Tainan respectively. Apart from continuing to supervise the development of the science parks, the Ministry of Science and Technology also plans to link industrial / academic collaboration and park services, and promote interchange and collaboration between in-park firms and peripheral academic research organizations through industrial cooperation channels, further enhancing the parks' industrial competitiveness. The Ministry will also strengthen the extension of research results, promoting the realization and application of research findings, and helping consolidate Taiwan's foundation for S&T development and high-tech industrial growth.
7. Planning nuclear safety policy and control: Nuclear safety and control will be handled by the Nuclear Safety Agency established under the Ministry of Science and Technology. The Nuclear Safety Agency will bear responsibility for safety oversight of domestic nuclear facilities and workplaces where radiation is used, the safety and security of nuclear energy, ionizing radiation, and radioactive materials, nuclear accident response, environmental radiation monitoring, and the safety of applications of nuclear energy.

Furthermore, after organizational reengineering, the NSC's existing interagency coordination duties will be transferred to the Science and Technology Meeting of the Executive Yuan.

As soon as the foregoing draft plan has been passed by the Executive Yuan conference, it will be sent to the Legislative Yuan for deliberation, and the "Ministry of Science and Technology Preparatory Committee" will be established to bear responsibility for various matters associated with organizational reengineering, so that preparatory matters involving the Ministry's operation can be completed while the Legislative Yuan performs deliberation.

Chapter 2

# Promoting Nationwide Scientific and Technological Development

Nationwide R&D Funding

National R&D Manpower

Science and Technology Research Results

# I. Nationwide R&D Funding

Taiwan's total research and development funding in 2005 was NT$280.98 billion, and this figure increased steadily to NT$367.17 billion in 2009. Funding grew at an annual rate of 4.5% in 2009, and the average growth rate over the most recent five years was 6.9%. The growth rate in 2009 was the lowest during this five-year period; although the government increased its 2009 R&D funding compared with the previous year, that private sector reduced its capital expenditures on R&D compared with 2008 due to the financial crisis and recession in the second half of the latter year, and growth in routine spending slowed. As a result, the private sector's 2009 R&D funding growth was less than in the past and less than the growth of government funding, and private R&D funding contributions consequently accounted for a lower percentage of total funding than in 2008.

R&D funding as a share of GDP increased steadily from 2.39% in 2005 to 2.94% in 2009. This was chiefly due to the continued growth of R&D funding, also reflected the negative GDP growth that occurred during two years at the height of the recent recession. The nation's economic growth surged in 2010. According to the projections of the Directorate General of Budget, Accounting & Statistics, the economy will continue to grow strongly. In view of the current situation, apart from continued stable growth of private sector funding, the government must maintain and increase its R&D inputs if Taiwan is to meet the goal of investing 3% of GDP on R&D by 2012.

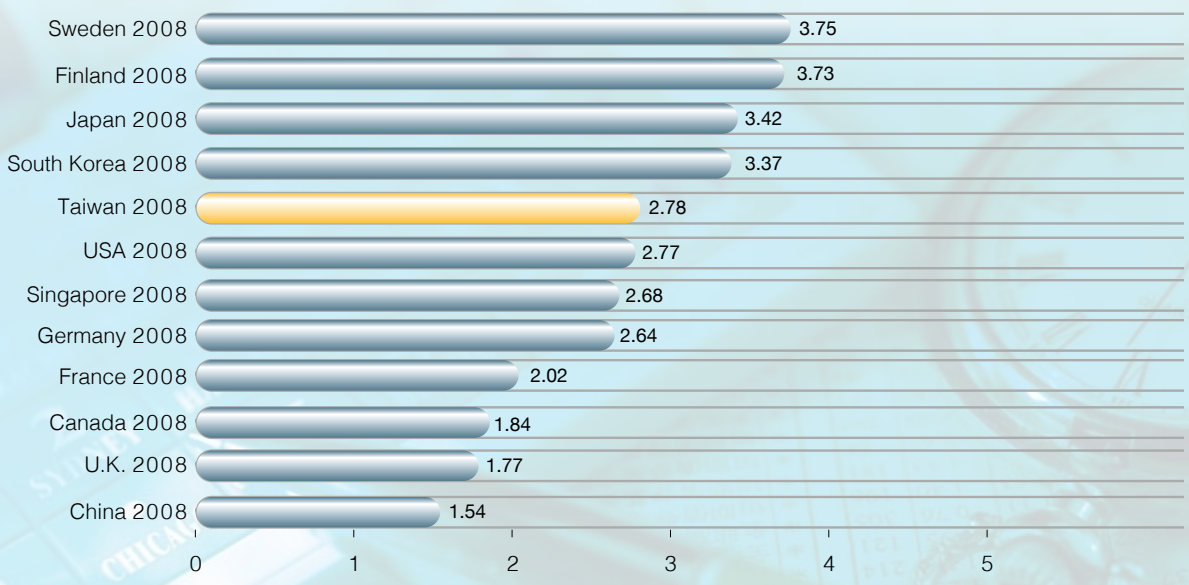
When Taiwan's R&D funding as a share of GDP is compared with the corresponding figures for other countries, Taiwan lags behind Sweden, Finland, South Korea, and Japan; is roughly on a par with the United States, and leads Germany, France, Canada, Britain, and China.

**National R&D Funding, 2005-2009**

| Item | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|
| National R&D funding (NT$1m) | 280,980 | 307,037 | 331,386 | 351,405 | 367,174 |
| Percentage of GDP (%) | 2.39 | 2.51 | 2.57 | 2.78 | 2.94 |
| By funding source (%) | | | | | |
| Government | 31.5 | 31.4 | 29.9 | 28.2 | 28.9 |
| Private sector | 68.5 | 68.6 | 70.1 | 71.8 | 71.1 |

Source: Indicators of Science and Technology, ROC, 2010, National Science Council, Executive Yuan.

**R&D funding as a Share of GDP in Various Countries**




Source: *Main Science and Technology Indicators*, 1/2010, OECD

# II. National R&D Manpower

R&D personnel in Taiwan are classified as researchers, technical personnel, and support personnel. Researchers have formed the mainstay of Taiwan's R&D manpower for many years, and accounted for 58.9%-60.5% R&D personnel during the most recent five years. Technical personnel are next most numerous, and support personnel are fewest. The number of researchers grew over the most recent five years from 88,859 FTE (full-time equivalent) persons-years in 2005 to 119,185 FTE in 2009; technical personnel grew from 49,471 FTE in 2005 to 65,444 FTE in 2009; and support personnel grew from 10,824 FTE in 2005 to 12,264 FTE in 2009. Of the three types of R&D personnel, the number of researchers has grown the fastest, while support personnel increased the slowest. As a result, the researchers have accounted for a steadily growing share of all research personnel.

The number of female researchers rose from 16,563 FTE in 2005 to 23,245 FTE in 2009. In addition, the women researchers as a share of all researchers grew from 18.6% in 2005 to 19.5% in 2009.

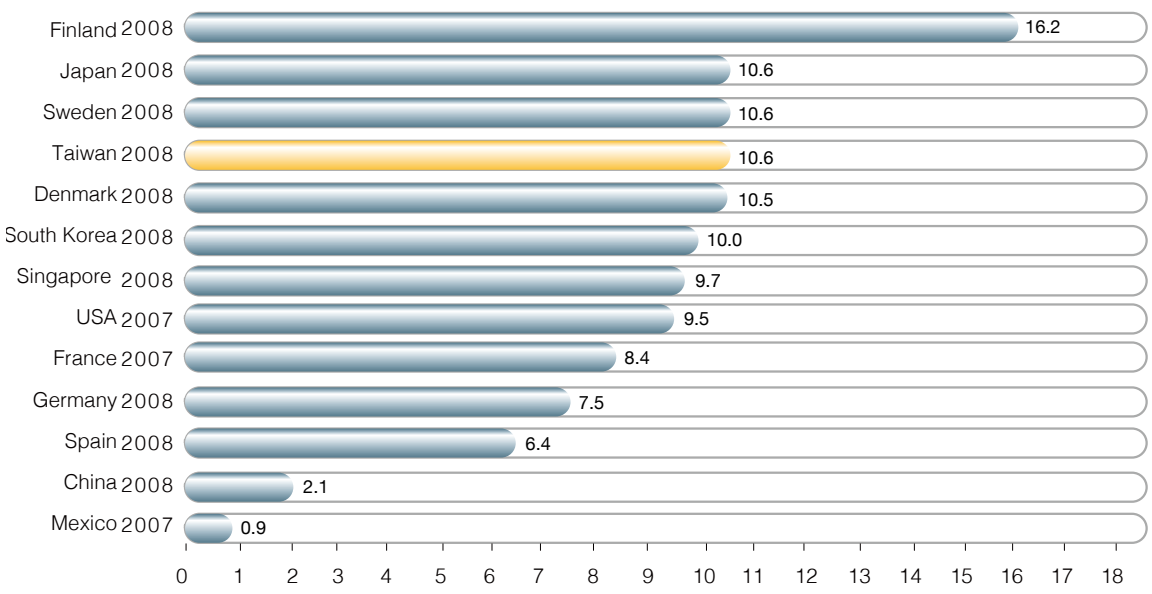
The number of FTE research personnel per 1,000 working population has also risen steadily over the past recent five years, and reached 11.6 person-years in 2009. Compared with other countries, the number of FTE R&D personnel per 1,000 working population in Taiwan was less than in Finland and Sweden; on a par with Japan; and greater than in South Korea, France, Canada, Germany, Britain, and China.

**Taiwan's R&D Manpower, 2005-2009**

| Item | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|
| R&D manpower FTE( person-years) | 149,154 | 161,314 | 175,741 | 184,633 | 196,893 |
| Researchers | 88,859 | 95,176 | 103,455 | 110,089 | 119,185 |
| Technical personnel | 49,471 | 54,519 | 59,868 | 62,936 | 65,444 |
| Support personnel | 10,824 | 11,619 | 12,418 | 11,608 | 12,264 |
| FTE female research personnel (person-years) | 16,563 | 18,558 | 19,650 | 20,746 | 23,245 |
| Female research personnel as a percentage of all research personnel (%) | 18.6 | 19.5 | 19.0 | 18.8 | 19.5 |
| Number of research personnel per 1,000 working population (person-years) | 8.9 | 9.4 | 10.0 | 10.6 | 11.6 |

Source: *Indicators of Science and Technology*, ROC, 2010, National Science Council, Executive Yuan

**FTE Research Personnel per 1,000 Working Population in Various Countries**




Source: *Main Science and Technology Indicators,* 2010/1, OECD

# III. Science and Technology Research Results

A total of 24,305 research papers by authors from Taiwan were cited in *Science Citation Index* (*SCI*) in 2009, giving Taiwan a world rank of 16th. A total of 18,869 research papers from Taiwan were cited in *Engineering Index* (*EI*) in 2009, giving Taiwan a world rank of 9th. In order to shed light on the quantity and quality of Taiwan's research output, the following sections compare Taiwan with eight leading industrialized countries and the chief top-ranking Asian countries in terms of the three indicators of number of *SCI*-cited papers per million citizens, *SCI* impact factor, and number of *EI* papers per million citizens.

## (1) Number of *SCI*-cited papers per million citizens

This indicator is calculated by dividing the average number of papers cited in *SCI* during the most recent five years by the average population during the most recent five years. Taiwan's 585 *SCI*-cited papers per million persons in 2005 had risen to 874 by 2009, putting Taiwan behind Singapore, Canada, Britain, the US, Germany, and France, but ahead of Italy, South Korea, Japan, Russia, China and India. Singapore has performed best in this category, increasing its output from 1,246 cited papers in 2005 to 1,572 in 2009. Among the countries included in this comparison, China's output of cited papers grew at the fastest average rate between 2005 and 2009 (17.4%), but its relative output still remains far behind most of the other countries. Both South Korea and Taiwan have had average growth rates in excess of 10% throughout the most recent five years. But while South Korea has lagged behind Taiwan, its output rose from 437 cited papers per million persons in 2005 to 648 cited papers in 2009.

## (2) *SCI* Impact Factor

This indicator is calculated by dividing the number of times papers were cited during the most recent five years by the total number of published papers during the most recent five years. The European and North American countries generally have high impact factors, and the US, Britain, Germany, and Canada all had impact factors higher than six in 2009. Taiwan's impact factor rose from 2.65 in 2005 to 3.37 in 2009, which shows that the quality of Taiwan's academic papers is improving, although it still lags behind that of the leading European and North American countries, Japan, Singapore, and South Korea. China's *SCI* impact factor rose quickly from 2.30 in 2005 to 3.22 in 2009, as China gradually catches up to Taiwan. In comparison with South Korea and China, Taiwan has made relatively slow progress in improving the quality of its academic papers.

**Number of *SCI*-Cited Papers per Million Persons and Average Growth Rate in Various Countries, 2005-2009**

**Units:cited papers**

| Item | 2005 | 2006 | 2007 | 2008 | 2009 | Average growth rate, 2005-2009 (%) |
|---|---|---|---|---|---|---|
| Singapore | 1,246 | 1,362 | 1,431 | 1,496 | 1,572 | 6.0 |
| Canada | 1,192 | 1,256 | 1,318 | 1,389 | 1,474 | 5.4 |
| Britain | 1,233 | 1,257 | 1,289 | 1,327 | 1,376 | 2.8 |
| USA | 953 | 973 | 991 | 1,015 | 1,045 | 2.3 |
| Germany | 868 | 888 | 908 | 941 | 988 | 3.3 |
| France | 848 | 860 | 872 | 901 | 943 | 2.7 |
| Taiwan | 585 | 642 | 704 | 783 | 874 | 10.6 |
| Italy | 640 | 666 | 694 | 729 | 769 | 4.7 |
| South Korea | 437 | 487 | 528 | 586 | 648 | 10.4 |
| Japan | 599 | 602 | 602 | 601 | 609 | 0.4 |
| Russia | 178 | 173 | 174 | 177 | 184 | 0.9 |
| China | 39 | 46 | 54 | 63 | 74 | 17.4 |
| India | 20 | 21 | 23 | 26 | 29 | 9.6 |

Source: 1. *SCI*-cited papers: *National Science Indicators 2010*, Thomson Reuters Co., USA
2. Population figures: World Bank web site http://www.worldbank.org/

### (3) Number of *EI* Citations per Million Persons

This indicator is calculated by dividing the average number of papers cited in *EI* over the most recent five years by the average population during the same five-year period. During the five-year period examined here, Singapore's citation rate was highest, followed by Taiwan and then Canada. Taiwan's *EI* citation output rose from 374 papers per million persons in 2005 to 678 papers in 2009, for an average growth rate of 16.1%. This growth rate was lower than only China's 28.3% and India's 16.6%, and higher than that of South Korea and other countries.

**_SCI_ Impact Factors of Various Countries, 2005-2009**

| Item | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|
| USA | 6.38 | 6.51 | 6.65 | 6.85 | 7.08 |
| Britain | 5.75 | 5.96 | 6.08 | 6.39 | 6.75 |
| Germany | 5.37 | 5.56 | 5.76 | 6.06 | 6.40 |
| Canada | 5.21 | 5.32 | 5.52 | 5.78 | 6.10 |
| France | 4.94 | 5.07 | 5.24 | 5.50 | 5.82 |
| Italy | 4.77 | 4.98 | 5.12 | 5.43 | 5.75 |
| Singapore | 3.01 | 3.46 | 3.94 | 4.47 | 4.92 |
| Japan | 4.16 | 4.26 | 4.41 | 4.61 | 4.76 |
| South Korea | 2.79 | 2.93 | 3.11 | 3.29 | 3.49 |
| Taiwan | 2.65 | 2.80 | 2.94 | 3.14 | 3.37 |
| China | 2.30 | 2.47 | 2.69 | 2.92 | 3.22 |
| India | 2.14 | 2.31 | 2.47 | 2.65 | 2.84 |
| Russia | 2.03 | 2.18 | 2.23 | 2.37 | 2.41 |

Source: *National Science Indicators 2010*, Thomson Reuters Co., USA

**Number of *EI* Citations per Million Persons and Five-year Average Growth Rate in Various Countries, 2005-2009**

Units: papers

| Item | 2005 | 2006 | 2007 | 2008 | 2009 | Average growth rate, 2005-2009 (%) |
|---|---|---|---|---|---|---|
| Singapore | 858 | 941 | 1,032 | 1,087 | 1,056 | 5.3 |
| Taiwan | 374 | 436 | 530 | 611 | 678 | 16.1 |
| Canada | 374 | 427 | 485 | 515 | 528 | 9.0 |
| South Korea | 229 | 271 | 323 | 362 | 395 | 14.6 |
| Britain | 297 | 329 | 362 | 377 | 382 | 6.5 |
| France | 235 | 262 | 291 | 311 | 326 | 8.6 |
| USA | 319 | 331 | 335 | 333 | 317 | -0.1 |
| Germany | 238 | 263 | 289 | 303 | 317 | 7.5 |
| Japan | 265 | 289 | 310 | 313 | 316 | 4.5 |
| Italy | 186 | 208 | 233 | 249 | 259 | 8.6 |
| China | 32 | 41 | 54 | 69 | 87 | 28.3 |
| Russia | 70 | 73 | 76 | 79 | 79 | 3.0 |
| India | 8 | 9 | 11 | 12 | 14 | 16.6 |

Source: 1. *EI*-cited articles: Compendex, Elsevier Inc., USA, retrieved in October, 2010
2. Population figures: World Bank web site http://www.worldbank.org/

Chapter 3

# Support for Academic Research


Support for Specific-topic Research Projects

R&D Achievements in Individual Disciplines

Manpower Recruiting and Training

Research Awards

International Cooperation in Science and Technology

S & T Interchange with China

Improving the Research and Development Environment

Management and Extension of Research Results

Increasing Citizens' S&T Knowledge

Publications

# I. Support for Specific-topic Research Projects

## A. Funding Principles and Methods

By supporting scientific and technological research work at universities and research organizations, the NSC's specific-topic research project funding thereby improves the country's research and development standards. All instructors and research personnel who meet the NSC's specific-topic research project funding application requirements may, within a specified period of time, apply to the NSC for research implementation funding, research equipment funding, or foreign travel funding based on the needs of their projects. Furthermore, in order to encourage long-term, in-depth research, the NSC also promotes multi-year projects, especially in the fields of natural science, engineering and applied technology, and life science / medicine / agriculture.

After a specific-topic research project funding application has been accepted, a two-stage review process consisting of initial and follow-up review in the relevant field is performed. Review results are submitted to the NSC Service Panel for approval, and an applicant who disagrees with the results of review may appeal to the NSC. As a rule, project funding is disbursed in annual installments. If, during the implementation period, a project has needs that differ from those of the originally-approved project items or funding amounts, or if the project implementation period must be extended, the principal investigator must perform change procedures in accordance with regulations. A project results report must be submitted and funding closure procedures performed within three months after the end of the implementation period.

The *National Science Council Specific-topic Research Project Funding Guidelines* were revised in July and again in October of 2010 in order to better meet practical service needs. The revisions specify that, if the NSC discovers following audit of evidence of expenditures from an applicant organizations implementing an NSC-funded research project that expenditures may have been over-reported or reported untruthfully, the NSC must notify the applicant organization to take appropriate action, and may ask the applicant organization and principal investigator to submit a written explanation. If review by the NSC's case task force indicates that serious over-reporting or false reporting has occurred, and feels that the case should be turned over to investigative units for possible prosecution, the case shall be referred for investigation.

The second revision of the *Guidelines* consisted of the addition of the provision that, in the case of research personnel who have been full-time staff physicians for two years or more or full-time research personnel holding doctoral degrees who have done research work for two years or more, when such persons have been contract employees of public teaching hospitals using medical operation fund monies, and have published papers in prominent domestic or foreign academic periodicals, they shall be eligible to apply for specific-topic research project funding. Different funding applications for a single research project may not be made to different NSC academic departments or different disciplines; violations of this regulation shall be handled in accordance with the NSC's Academic Ethics Case Handling and Review Guidelines.

## B. Project Types

Specific-topic research projects are classified as either individual or integrated projects. Individual projects encompass research in the applicant's area of specialization or on a topic proposed in the NSC's discipline plan. Integrated projects include main projects and subprojects. The principal investigator of a main project shall organize a research team to address one of the mission-oriented focal research topics laid out by the NSC in its discipline plan, and shall propose an interdisciplinary or inter-university project, or organize a team research project on some specific topic.

## C. Funding

A total of 20,635 specific-topic research projects were implemented during 2010 (including 14,463 newly-approved 2010 projects, 3,750 second-year projects of multi-year projects approved in 2009, 2,420 third-year projects of multi-year projects approved in 2008, one fourth-year project of a multi-year projects approved in 2007, and one fifth-year of a multi-year projects approved in 2006). Total implemented funding was NT$21.83 billion, of which 63.25% went to research at public universities and colleges, 21.70% went for research at private universities and colleges, and 15.05% went for research at government

**Specific-topic research project statistics, 2006-2010**

| Item | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|
| Project applications[2] | 31,029 | 28,789 | 27,279 | 28,480 | 30,142 |
| Approved projects[2] | 17,776 | 14,993 | 12,840 | 13,590 | 14,463 |
| Approval rate | 57.29% | 52.08% | 47.07% | 47.72% | 47.98% |
| Implemented projects[2] | 17,776 | 17,749 | 18,295 | 19,706 | 20,635[1] |

[1] Projects implemented in 2010 include projects approved in 2010, second-year projects of multi-year projects approved in 2009, third-year projects of multi-year projects approved in 2008, fourth-year projects of multi-year projects approved in 2007, and fifth-year projects of multi-year projects approved in 2006.

[2] Also includes other fields in addition to natural science, engineering, life science, humanities and social sciences, and science education.

research organizations and other units. One-year projects accounted for 32.76% of the total, and multi-year projects accounted for 67.24%. Basic research projects accounted for 53.81% of the total, applied research projects accounted for 38.53%, and technology development projects accounted for 7.66%. Natural science projects accounted for 21.38% of the total, engineering and applied science projects accounted for 28.58%, life science/medicine/agriculture research projects accounted for 29.60%, humanities and social science projects accounted for 13.90%, science education projects accounted for 4.64%, and other projects accounted for 1.90%.

**Numbers of Specific-topic Research Projects at Different Types of Organizations and Funding, 2006-2010** **Units: NT$1 m**

| Item | 2006 | | 2007 | | 2008 | | 2009 | | 2010 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Projects | Funding | Projects | Funding | Projects | Funding | Projects | Funding | Projects | Funding |
| Public universities | 10,364 | 11,040.69 | 10,489 | 11,379.29 | 11,002 | 12,002.25 | 11,846 | 13,613.42 | 12,291 | 13,807.82 |
| Private universities | 5,583 | 3,560.56 | 5,424 | 3,583.94 | 5,469 | 3,914.12 | 5,972 | 4,431.39 | 6,325 | 4, 737.57 |
| Military / police schools | 280 | 209.74 | 264 | 212.62 | 234 | 193.43 | 235 | 222..49 | 233 | 204.59 |
| Government research organizations | 834 | 1,357.84 | 889 | 1,833.75 | 905 | 1,832.21 | 910 | 1,832.87 | 939 | 1,656.19 |
| Juridical person academic research organizations | 143 | 365.54 | 163 | 342.80 | 160 | 322.05 | 183 | 411.74 | 239 | 440.00 |
| Teaching hospitals | 568 | 545.96 | 517 | 532.82 | 522 | 550.12 | 558 | 606.55 | 600 | 629.57 |
| Other | 4 | 5.09 | 3 | 5.92 | 3 | 32.22 | 2 | 2.88 | 8 | 356.35 |
| **Total** | 17,776 | 17,085.42 | 17,749 | 17,891.14 | 18,295 | 18,846.40 | 19,706 | 21,121.34 | 20,635 | 21,832.09 |

**Numbers of Funded Basic Research, Applied Research, and Technology Development Specific-topic Projects and Funding, 2006-2010**

**Units: NT$1 m**

| Item | 2006 | | | 2007 | | | 2008 | | | 2009 | | | 2010 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Projects | Funding | % of funding | Projects | Funding | % of funding | Projects | Funding | % of funding | Projects | Funding | % of funding | Projects | Funding | % of funding |
| Basic research | 8,779 | 9,898.40 | 57.94 | 8,966 | 10,234.08 | 57.20 | 9,612 | 10,765.73 | 57.12 | 10,188 | 11,571.76 | 54.79 | 10,619 | 11,749.06 | 53.81 |
| Applied research | 7,157 | 5,778.67 | 33.82 | 6,956 | 6,042.93 | 33.78 | 7,536 | 6,764.16 | 35.89 | 8,274 | 7,953.04 | 37.65 | 8,830 | 8,411.28 | 38.53 |
| Technology development | 1,840 | 1,408.35 | 8.24 | 1,827 | 1,614.13 | 9.02 | 1,147 | 1,316.52 | 6.99 | 1,244 | 1,596.54 | 7.56 | 1,186 | 1,671.75 | 7.66 |
| **Total** | 17,776 | 17,085.42 | 100 | 17,749 | 17,891.14 | 100 | 18,295 | 18,846.40 | 100 | 19,706 | 21,121.34 | 100 | 20,635 | 21,832.09 | 100 |

**Numbers of Funded Specific-topic Research Projects in each Research Area and Funding, 2006-2010** **Units: NT$1 m**

| Item | 2006 | | 2007 | | 2008 | | 2009 | | 2010 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Projects | Funding | Projects | Funding | Projects | Funding | Projects | Funding | Projects | Funding |
| Natural science | 2,055 | 3,684.31 | 2,081 | 3,737.21 | 2,516 | 4,241.51 | 2,557 | 4,655.82 | 2,575 | 4,668.63 |
| Engineering | 7,076 | 5,477.00 | 6,703 | 5,286.57 | 6,773 | 5,724.34 | 7,411 | 6,848.48 | 7,371 | 6,240.35 |
| Life science | 3,805 | 4,656.76 | 3,814 | 5,114.32 | 3,826 | 5,242.94 | 4,268 | 5,979.94 | 4,589 | 6,460.24 |
| Humanities and social sciences | 3,636 | 2,043.34 | 3,989 | 2,506.53 | 4,378 | 2,742.20 | 4,594 | 2,692.83 | 5,044 | 3,035.43 |
| Science education | 661 | 595.75 | 644 | 643.28 | 778 | 725.50 | 853 | 810.17 | 1,033 | 1,013.74 |
| Sustainable development | 314 | 230.29 | 294 | 231.35 | - | - | - | - | - | - |
| Applied technology | 221 | 187.89 | 204 | 166.10 | - | - | - | - | - | - |
| Other | 8 | 210.08 | 20 | 205.78 | 24 | 169.93 | 23 | 134.10 | 23 | 413.69 |
| **Total** | 17,776 | 17,085.42 | 17,749 | 17,891.14 | 18,295 | 18,846.40 | 19,706 | 21,121.34 | 20,635 | 21,832.09 |

Note: Starting January 1, 2008, sustainable development projects and their funding have been included in natural science, and applied technology projects and their funding have been included in engineering.

**Numbers of One-year and Multi-year Specific-topic Research Projects and Funding, 2006-2010** **Units: NT$1 m**

| Item | 2006 | | 2007 | | 2008 | | 2009 | | 2010 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Projects | Funding | Projects | Funding | Projects | Funding | Projects | Funding | Projects | Funding |
| **One-year projects** | | | | | | | | | | |
| Natural science | 923 | 1,098.78 | 740 | 857.00 | 1,001 | 1,123.82 | 982 | 1,200.59 | 934 | 1,072.55 |
| Engineering | 4,459 | 2,555.24 | 3,736 | 2,089.52 | 3,625 | 2,513.48 | 4,080 | 3,196.28 | 4,128 | 2,681.55 |
| Life science | 1,887 | 1,879.15 | 1,237 | 1,393.78 | 618 | 779.15 | 577 | 938.19 | 640 | 1,171.73 |
| Humanities and social sciences | 2,794 | 1,424.51 | 2,382 | 1,428.06 | 2,378 | 1,441.80 | 2,686 | 1,383.99 | 2,995 | 1,569.93 |
| Science education | 270 | 168.80 | 240 | 171.84 | 240 | 151.64 | 256 | 183.28 | 413 | 398.99 |
| Sustainable development | 294 | 211.49 | 246 | 185.70 | - | - | - | - | - | - |
| Applied technology | 215 | 183.31 | 187 | 153.45 | - | - | - | - | - | - |
| Other | 7 | 207.63 | 9 | 168.19 | 12 | 144.97 | 3 | 65.66 | 13 | 257.25 |
| Subtotal | 10,849 | 7,728.91 | 8,777 | 6,447.53 | 7,874 | 6,154.86 | 8,584 | 6,967.99 | 9,123 | 7,152.00 |
| **Multi-year projects** | | | | | | | | | | |
| Natural science | 1,132 | 2,585.53 | 1,341 | 2,880.41 | 1,515 | 3,117.69 | 1,575 | 3,455.22 | 1,641 | 3,596.08 |
| Engineering | 2,617 | 2,921.76 | 2,967 | 3,197.05 | 3,148 | 3,210.86 | 3,331 | 3,652.20 | 3,243 | 3,558.81 |
| Life science | 1,918 | 2,777.61 | 2,577 | 3,720.54 | 3,208 | 4,463.78 | 3,691 | 5,041.75 | 3,949 | 5,288.52 |
| Humanities and social sciences | 842 | 618.83 | 1,607 | 1,078.47 | 2,000 | 1,300.40 | 1,908 | 1,308.84 | 2,049 | 1,465.50 |
| Science education | 391 | 426.95 | 404 | 471.44 | 538 | 573.85 | 597 | 626.90 | 620 | 614.75 |
| Sustainable development | 20 | 18.79 | 48 | 45.65 | - | - | - | - | - | - |
| Applied technology | 6 | 4.58 | 17 | 12.65 | - | - | - | - | - | - |
| other | 1 | 2.46 | 11 | 37.59 | 12 | 24.96 | 20 | 68.44 | 10 | 156.44 |
| Subtotal | 6,927 | 9,356.51 | 8,972 | 11,443.61 | 10,421 | 12,691.54 | 11,122 | 14,153.35 | 11,512 | 14,680.10 |
| **Total** | 17,776 | 17,085.42 | 17,749 | 17,891.14 | 18,295 | 18,846.40 | 19,706 | 21,121.34 | 20,635 | 21,832.09 |

Note: Starting January 1, 2008, sustainable development projects and their funding have been included in natural science, and applied technology projects and their funding have been included in engineering.

**Numbers of Male and Female Principal Investigators of Specific-topic Projects, 2006-2010**

| Item | 2006 | | 2007 | | 2008 | | 2009 | | 2010 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Person times | Percentage | Person times | Percentage | Person times | Percentage | Person times | Percentage | Person times | Percentage |
| Female | 3,299 | 18.56 | 3,497 | 19.70 | 3,756 | 20.53 | 4,118 | 20.90 | 4,469 | 21.66 |
| Male | 14,477 | 81.44 | 14,252 | 80.30 | 14,539 | 79.47 | 15,588 | 79.10 | 16,166 | 78.34 |
| **Total** | 17,776 | 100 | 17,749 | 100 | 18,295 | 100 | 19,706 | 100 | 20,635 | 100 |

# II. R&D Achievements in Individual Disciplines

## A. General Specific-topic Research Projects

### 1. Natural Science

Natural science research, which chiefly takes the form of basic scientific research, encompasses the five main areas of mathematics/statistics, physics, chemistry, earth science, and sustainable development. In order to strengthen interdisciplinary research involving the natural sciences and other areas of science and technology, while also taking into consideration international academic research trends, the NSC has been actively planning and implementing focused research in relevant areas, and has sought to achieve the goals of promoting the long-term cultivation of natural science manpower and basic research pursuing academic excellence. The following were among some of the most significant research results of the year:

(1) Clustering analysis of functional data

The representation data in functional form is an important method of data analysis, and much progress has been made in this area during the past one or two decades. Since 2000, the theory and method of functional data analysis has been widely applied to such fields as biomedicine, agricultural science, quantitative chemistry, meteorology, psychology, behavioral science, marketing, quantitative finance, demographic forecasting, brain imaging, and linguistics.

This research explored clustering analysis of functional data, and employed random function expansion and the subspace projection method. Subspaces obtained from the analysis of the principal components of functions were used to define different clusters, and cluster analysis was then performed on the basis of the derived clustering rules. The most important finding of this research was the fact that clustering goals can be achieved through the definition of various similar inferences. The research also considered the characteristics of the subspace average function and covariance structure of clusters, which will facilitate understanding of cluster systems and random structural differences. The statistical significance of structural differences in clusters can be used to determine the number of clusters. The methods elucidated in this work can be used in cluster analysis of functional data, which can be widely applied in such areas as growth curve analysis and the presentation of cDNA microarray data.

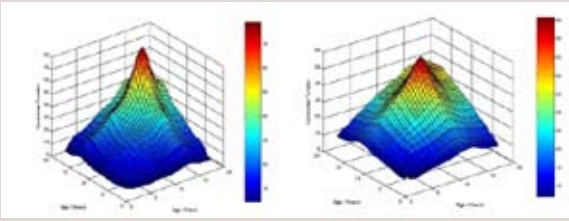
(2) Quantum dot-sensitized solar cells

The research team in this project successfully developed highly electrocatalytic cobalt sulfide (CoS) electrodes, which they used in conjunction with cadmium sulfide/selenium sulfide (CdS/CdSe) nanomaterial as a light-absorbing material. By successfully boosting the efficiency of CdS/CdSe quantum dot-sensitized solar cells (QDSSCs) to 3.4%, the project resolved the current low efficiency (<3%) of quantum dot-sensitized solar cells. The results of this work are being published in the international journal *Chemical Communications*.

The research team relied on adjustment of the ratio of cobalt ions to thioacetamide to boost the efficiency of quantum dot-sensitized solar cells, and synthesized hexagonal CoS core shell nanosheets (with a side length of approximately 75 nm and thickness of 20-30 nm). The team was also able to control the size of the pores between core shells, enabling them to synthesize hexagonal CoS nanosheets with different core shell shapes. Because this type of nanosheet has high catalytic ability and excellent durability toward polysulfide electrolytes, the nanosheets can be used in quantum dot-sensitized solar cells. Experimental results revealed that the use of CoS nanosheets as counter electrode can increase the efficiency of quantum dot-sensitized solar cells to 3.7%.

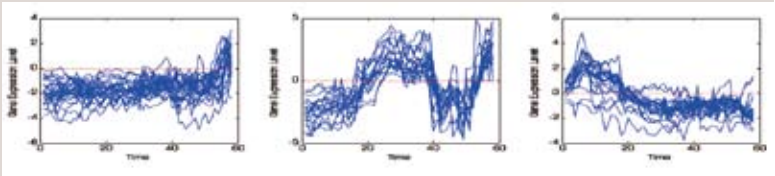
(3) Development of high-performance solid dye-sensitized solar cells

A research team successfully used anodization in the development of titanium dioxide nanotube array technology, and further used the nanotubes to prepare dye-sensitized solar cell elements. The resulting small-area NT-DSSC elements produced using anodization have an efficiency of as high as 7.0% when in the form of tubes 20 m in length. The preliminary results of this work were published in the American Chemical Society's *Journal of Physical Chemistry*, and this article had already been cited 17 times prior to December 1, 2010. Other articles have also been published as a result of subsequent research in this project, which has recently developed new technology. By employing a constant voltage/constant current hybrid anodic method, the researchers found that the length of titania nanotubes (TNTs) has a linear relationship with the time of anodization. They were also able to grow very long TiO2 nanotube arrays in a short time, and increased the elements' photoelectric conversion efficiency



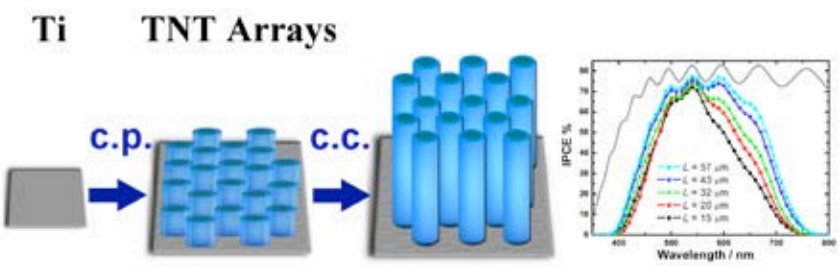
**Growth curve analysis: Growth curve covariance structure of cluster 1 (men) and cluster 2 (women)**

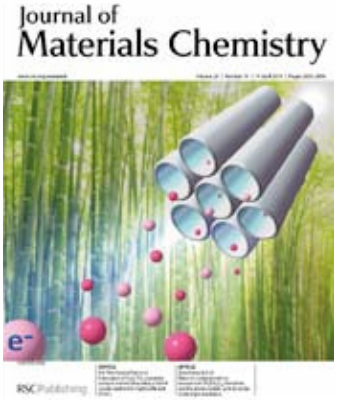
**Source: *Natural Sciences Newsletter*, Vol. 22, no. 3, p. 107-110.**



**Display of cDNA microarray data: Longitudinal sections resulting from functional clustering analysis of gene expression in the fruit fly (Drosophilia) life cycle. From left to right, the three clusters consist of eye-specific, muscle-specific, and transient early zygotic genes.**

**Source: Journal of the Royal Statistical Society Ser. B v69, 679–699.**




**Schematic diagram of the two-stage constant voltage (c.p.)/constant current (c.c.) anodization method. The IPCE results reveal that the NT-DSSC element achieves even better chromatic dispersion performance as tube length increases. This article appeared as the cover story of JMC.**

**Source: Journal of Materials Chemistry 2010, 20, 2753-2758.**

to a world record 7.6%. The results of this part of the project have been published in the prominent British material science periodical *Journal of Materials Chemistry*, and the article was chosen as the issue's cover story.

(4) Application of advanced nano-composite structures to a micro-methanol reforming reactor

Proton exchange membrane fuel cells are currently thought to possess great potential as a portable source of green energy. Although safety concerns and the difficulty of storing and refilling hydrogen at the anode end have thus far limited the commercialization of these fuel cells as a portable, alternative energy source, the use of the methanol reforming reaction to efficiently generate hydrogen is currently considered a promising method of resolving these problems. The goal of this project was to develop a high-performance, low-cost micro-methanol reforming reactor facilitating the development of hydrogen as a clean energy source. Because conventional fixed and/or large methanol reforming reactors cannot be used in portable applications, there has been increasing interest in micro-reactors in recent years. The largest problem facing the development of a micro-reforming reactor is low catalyst activity due to the form of the membrane-type catalyst. In an effort to overcome this issue, the research team in this project dispensed with conventional thinking and adopted a nanostructure concept. Employing the simple, low-cost chemical solution method, the team grew novel ZnO-metallic copper core shell nano-composite structures directly in a micro-reactor, and used a catalyst with a porous inverse opal structure. This strategy enabled them to resolve the issues of how to shrink the size, reduce the cost, and enhance the efficiency of a reforming reactor. The researchers found that the nano-composite structures developed in this project achieved a high methanol conversion efficiency (>95%) and hydrogen yield at a very low reaction temperature, along with good catalyst stability and a low carbon monoxide concentration (<200 ppm). The results of this project have been published in Angewandte Chemie International Edition and Journal of Materials Chemistry.

(5) Research on the surface and interface physics of organic optoelectronic semiconductors

This project studied the surface and interface physical characteristics of organic semiconductors, and their effect on relevant organic semiconductor elements, facilitating the production of high-performance organic elements. During the course of this project, the researchers discovered that the field-effect mobility derived from the output and electrical conversion characteristics of organic thin film transistors (TFTs) exhibits inconsistencies. According to experimental results, the field-effect mobility derived from the electrical conversion characteristics of organic TFTs is higher than that derived from the output electrical characteristics of organic TFTs. This phenomenon is caused by the time variation in capacitance associated with the displacement current in organic semiconductor-oxide structures. Although the output electrical characteristics of organic TFTs is ordinarily observed by Keeping gate voltage fixed while changing the drain-source voltage, the electrical conversion characteristics of organic TFTs is observed by keeping drain-source voltage fixed while changing the gate voltage. The changing of the gate voltage contributes to the capacitance-time variation term, which causes the drain-source current to increase slightly, and thus leads to overestimation of field-effect mobility. This effect was neglected in most previous research. In addition, this study also verified the mechanism of leakage current among the electrical characteristics of TFT output.

(6) Relationship between convection height and weakening of tropical circulation under global warming

How will the climate change as global warming continues? Apart from foreseeing increasing surface temperatures and a rising sea level, current climate models give the very consistent prediction that tropical circulation will weaken. The strength of tropical circulation is very closely connected with the frequency and intensity of precipitation; apart from affecting our everyday water supply, changes in precipitation may also cause severe droughts and flooding.

Past research has employed a simple global energy balance concept to investigate the question of why tropical circulation is weakening. Increasing amounts of greenhouse gases such as carbon dioxide and water vapor are reducing the efficiency of radiation cooling, and the latent heat, emitted to balance radiation cooling when precipitation occurs, is restricted, preventing tropical circulation from maintaining its original strength. The research team in this project has revised this theory to make it more complete. Global warming has caused the top of the conviction layer to rise, which has induced tropical convection to rise and increase in thickness. A higher convection layer tends to stabilize the atmosphere, which weakens tropical circulation. This study not only proposed a more comprehensive theoretical basis explaining the weakening of tropical circulation, but also showed the importance of a high convection layer and low stratosphere in determining the strength of tropical circulation and stability of the atmosphere. These findings indicate that changes in the height of the convection layer should be another focus of future monitoring efforts.

(7) Development of a multi-scale fully-coupled sea-land-atmosphere model

This project established and developed the "Taiwan Multi-Scale Neighboring Ocean Model," which is able to simulate all dimensional scales. This model has been placed in the public domain for use by all domestic and foreign marine researchers and oceanographers. The project team has also cooperated with domestic and foreign scientists in developing the first global system model for Taiwan; this model can simulate the interactions between the sea, land, and atmosphere. The research process included establishment and development of a numerical model, verification of modeling results, and multifaceted analysis of results. In particular, the multi-scale neighboring sea model created in the project is Taiwan's first domestically-developed and improved neighboring ocean model, and its multi-scale coupling methods are unique in the world. The model can be used to simultaneously simulate various kinds of trans-scale questions concerning the sea. In the future, the researchers will continue to use the world's only high-resolution parallel computing-based global ocean model to study the global marine and climate changes. The project's high-resolution ocean and climate research findings will constitute important results in the future research reports of international inter-governmental organizations.

This project's model has been used to investigate typhoon-induced response in the ocean, the origin of nonlinear internal waves in the Luzon Strait, the Kuroshio Current's invasion of the Taiwan Strait, the origin of water masses in the Taiwan Strait, and the influence of high-salinity water masses from the Mediterranean on the world's thermohaline circulation. The project's findings will be published in *Progress in Oceanography*, which has an extremely high impact factor in oceanography and earth science. The publication of these research results will enable the international oceanographic community the importance and value of the project, and increase awareness of Taiwan's achievements in global ocean and climate change research.

(8) Promotion of local sustainable development through cultural preservation and innovation: Research on indigenous communities in the Hualien area

Major international environmental organizations and documents during the past decade or more have emphasized the importance of indigenous culture in environmental protection and the coevolution between indigenous sociocultural development and the local ecology. These points of view have since become the subject of much research conducted by the international academic community. Furthermore, many scholars believe that the preservation of indigenous cultures is an important means of natural conservation in today's world. These ideas are very closely connected with this project's conceptual content of "promotion of local sustainable development through cultural preservation and innovation."

Many indigenous groups have lived in the Hualien area for a very long time. These indigenous peoples use resources provided by nature in community life, which has also enabled them to accumulate great ecological knowledge and develop diverse cultures. This project studied Tongli Village near the mouth of Taroko Gorge in the Hualien area, Jilakayang Village in Fenglin Township, and Dalanfu Village in Fuli Township. These three communities all possess their own unique cultural models of coexistence with nature, and are also actively involved in local sustainability activities. Among the communities, Tongli Village is chiefly engaged in ecotourism, while Dalanfu and Jilakayang villages are developing organic agriculture with assistance from the private organization World Vision Taiwan. Apart from research on the individual communities, the researchers relied on private organizations, government agencies at different levels, and policies to link the different parts of the project. The project found that, beyond the activities of individual communities, the establishment of partnerships and assistance from government policies and systems are indispensable preconditions for local sustainability.

This integrated project examined three indigenous communities in the Hualien area, investigated the relationship between local sustainability and the communities' cultural preservation and innovation, and looked at the establishment of partnerships with private groups. The chief conclusions of the project included: (1) the smooth, united functioning of community organizations constitutes a key advantageous condition for a village's adoption of organic agriculture or ecotourism; in this project, Dalanfu Village was able to successfully develop organic agriculture thanks to the support provided by local churches; (2) in Tongli Village, residents found that depending solely on ecotourism was insufficient to ensure survival; farming was found to provide a more stable source of income. But while ecotourism could serve as an income-generating sideline at best, it could play an important role in transmitting and passing on the village culture. (3) Private groups provided important technical and production-marketing assistance to Hualien area indigenous villages developing organic agriculture and ecotourism. In these cases, close cooperation between village organizations and the private groups proved to be a key factor promoting the development of village industries and local sustainability.

**Number of *SCI*-cited Papers in Natural Science and Mathematics, 2001-2010**

| Item | 2011 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| Mathematics, statistics | 539 | 540 | 607 | 719 | 723 | 727 | 875 | 985 | 1,091 | 933 |
| Physics, astronomy | 1,531 | 1,680 | 1,825 | 2,112 | 2,541 | 2,965 | 3,232 | 3,365 | 3,294 | 3,277 |
| Chemistry | 1,256 | 1,260 | 1,386 | 1,503 | 1,735 | 1,948 | 1,969 | 2,458 | 2,684 | 2,732 |
| Earth science, geology, atmospheric science, marine science | 368 | 388 | 385 | 397 | 431 | 495 | 488 | 466 | 498 | 438 |
| **Total** | 3,694 | 3,868 | 4,203 | 4,731 | 5,430 | 6,135 | 6,564 | 7,274 | 7,548 | 7,380 |

Source: SciSearch®: A Cited Reference Science Database http://www.dimdi.de/static/en/index.html

The data in this table is current to January 2011

**Numbers of Natural Science Specific-topic Research Projects and Funding, 2010** Units: NT$1 m

| Item | Applications | | Approved | | Implemented | |
|---|---|---|---|---|---|---|
| | Projects | Funding | Projects | Funding | Projects | Funding |
| Mathematics & statistics | 578 | 421.73 | 353 | 186.53 | 495 | 294.90 |
| Physics | 503 | 2,161.58 | 306 | 702.96 | 641 | 1,154.01 |
| Chemistry | 490 | 1,810.06 | 307 | 494.30 | 576 | 1,068.68 |
| Earth science | 583 | 1,375.51 | 350 | 555.00 | 424 | 697.23 |
| Sustainable development | 400 | 462.67 | 244 | 233.52 | 254 | 250.67 |
| Other | 229 | 2,735.59 | 184 | 1,188.14 | 185 | 1,203.14 |
| **Total** | 2,783 | 8,967.14 | 1,744 | 3,360.45 | 2,575 | 4,668.63 |

**Natural Science Specific-topic Research Project Manpower, 2006-2010** Units: person-times

| Item | | 2006 | 2007 | 2008 | 2009 | 2010[1] |
|---|---|---|---|---|---|---|
| Research personnel | Professors | 1,661 | 1,916 | 1,465 | 1,470 | 1,510 |
| | Associate professors | 914 | 1,008 | 693 | 727 | 745 |
| | Assistant professors | 967 | 1,124 | 854 | 862 | 833 |
| | Lecturers | 104 | 146 | 7 | 12 | 7 |
| | Other | 100 | 143 | 601 | 622 | 672 |
| Subtotal | | 3,746 | 4,337 | 3,620 | 3,693 | 3,767 |
| Research assistants | Full-time assistants | 644 | 622 | 710 | 797 | 811 |
| | Part-time assistants | 82 | 73 | 96 | 94 | 107 |
| | Graduate students | 7,245 | 7,242 | 8,380 | 9,115 | 9,385 |
| Subtotal | | 7,971 | 7,937 | 9,186 | 10,006 | 10,303 |
| **Total** | | 11,717 | 12,274 | 12,806 | 13,699 | 14,070 |

[1] 2010 data is to January 29, 2011.

**Numbers and Percentage of One-year and Multi-year Natural Science Specific-topic Research Projects, 2006-2010**

| Year | All projects | One-year projects (%) | Multi-year projects (%) |
|---|---|---|---|
| 2006 | 2,055 | 923 (44.91) | 1,132 (55.09) |
| 2007 | 2,081 | 740 (35.56) | 1,341 (64.44) |
| 2008 | 2,516 | 1,001 (39.79) | 1,515 (60.21) |
| 2009 | 2,536 | 982 (38.72) | 1,554 (61.28) |
| 2010 | 2,575 | 934 (36.27) | 1,641 (63.73) |

## 2. Engineering

Engineering and applied science research include 18 disciplines in the three broad areas of electronics/information/communications, mechanical engineering/electrical engineering/energy, and chemical engineering/materials/consumer applications, along with academic collaborative projects in applied technology. The chief goal of research in engineering and applied science is to employ specific-topic research project funding to promote basic research in engineering technology and train the high-level R&D manpower needed by industry. In light of the fact that interdisciplinary collaboration in science and technology is growing in importance, the NSC formulated the human-centered "Intelligent Living Technology Regional Integration Center Project," which brings together engineering experts and scholars of the humanities; addressing the need to enhance creative R&D in engineering, the NSC is promoting the "Forward-Looking Conceptual Design Project," which relies on dialog between engineers and design personnel to inspire R&D creativity, while also promoting horizontal interchange between personnel and training creative individuals in different fields. The "Integrated R&D Project on Civil System Energy Conservation Technologies," "Integrated Applied Research Project on Innovative Wireless Sensor and Network Technology," "Free Software and Embedded System R&D Project," "Interdisciplinary Project on Soft Electronics," "Biomedical Engineering Project on the Early Diagnosis and Treatment of Cancer," and "Interdisciplinary Integrated Project on Forward-looking Intelligent Lightweight Mobile Vehicle Technology" are aligned with the country's science and technology development policies and seek to perfect the interdisciplinary R&D environment, promote R&D on forward-looking technological applications, and develop key R&D technologies. The following are some of the project progress and results during the year:

(1) Intelligent Living Technology Regional Integration Center Project

This project integrated manpower and resources in such fields as civil engineering, architecture, electrical machinery, electronics, computers, machinery, materials, chemical engineering, medical engineering, design, environmental engineering, and humanities in order to establish three prototype "regional intelligent living technology integration centers" with their own individual features located in northern, central, and southern Taiwan. These centers are respectively the Center of Innovation and Synergy for Intelligent Home and Living Technology (INSIGHT Center) at National Taiwan University, the Eco-City Center at National Chiao Tung University, and the Center of Technologies of Ubiquitous Computing and Humanity (TOUCH Center) at National Cheng Kung University. Apart

from implementing interdisciplinary, inter-university integrated research relying on their superior resources and local features, the three centers are also promoting innovative intelligent living applications and training specialized manpower. By adopting the Living Labs innovation model, the centers have been able to develop concrete intelligent living technologies and knowledge integration platforms, and have also been vigorously promoting industry-academic collaboration, showcasing successful cases and applications, making optimal use of knowledge economy advantages, and strengthening Taiwan's regional competitive advantages. The project has also yielded innovative commercial, public interest, and community service chain models: For instance, the INSIGHT Center at National Taiwan University has worked together with convenience store operators to use the service-oriented convenience store chain model to provide convenient public service in intelligent ways. Working for the public benefit, the Eco-City Center at National Chiao Tung University developed specialized assistive gear and applications technology after analyzing the needs of persons with amyotrophic lateral sclerosis. The TOUCH Center at National Cheng Kung University used various intelligent living management systems within the scope of the National Cheng Kung University community to enable the public to experience convenient services, and established user-friendly services supported by technology. The emerging industry models developed at these centers will not only create bridges between industry and academic researchers, but also strengthen industrial competitiveness by forging links between different industries.

This project has taken the lead in Taiwan by establishing Living Labs research units. All three centers have stimulated creativity by adopting the novel international Living Labs concept and embracing distinctive local cultural features. By integrating the academic community's intelligent living R&D capabilities, the centers have incorporated the newest technologies in the applications domain, and are applying data accumulated from long-term user participate in real-life scenario research in trend research and general-purpose design, making them lifestyle pioneers providing distinctive products and services. The INSIGHT Center is currently collaborating with the Suan-Lien Elderly Center in a series of research projects focusing on senior citizens' welfare. The Eco-City Center is extending the intelligent living ecological city experience established in Hsinchu to other cities in order to increase the scale and depth of the Living Labs concept. The TOUCH Center has partnered with the Prince Housing & Development Corp. to initiate various services in such areas as environmental quality, residential management, community interaction, and time management via living experiences among the student population. In addition, because the centers in this project are pioneering research on the Living Labs concept in Taiwan, have held numerous seminars on this subject, and maintain close contact with Living Labs in Europe, they have become important windows for liaison and interchange between Europe and Asia.

Furthermore, each center has vigorously promoted international interchange and cooperation. For instance, the INSIGHT Center brokered the establishment of the IBM Intelligent Living Forward-looking Research Center in Taiwan; both the Ministry of Economic Affairs and IBM will invest NT$100 million annually in forward-looking service R&D at this center. The Eco-City Center has teamed up with the International Urban Development Association and Architectural Association to hold the "Knowledge Cluster Regional Planning and Knowledge Industry Program Design Forum," which promoted increased international interchange in urban planning and architecture.

(2) Forward-Looking Conceptual Design Project

This project, which is promoting forward-looking conceptual design involving interdisciplinary cooperation, has issued results encompassing "services, systems, and products." The project's results over the past four years (to the end of June, 2010) have earned 16 awards in international design competitions and seven awards in domestic design contests. These awards included the IF Concept Design Award, Red Dot Design Award, International Bicycle Design Competition, Design 21: Social Design Network, Taiwan Crafts Competition, Distinctive Culture Creativity Product Competition, International Industrial Design Contest, Cross-Strait Spatial Design Competition, and the Chaoxiang Future-Oriented Creativity Awards. In addition, in order to promote tangible interdisciplinary collaboration between design and engineering students and instructors, the "NSC Interdisciplinary Creativity Value-Added Promotion Plan" further promoted the results of two conceptual design projects. The progress made by each project team is announced on a dedicated web site (www.ideastorming.tw); as of October 15, 2010, a total of 1,292 members had posted 7,193 items of public conceptual data (or 10,823 items including confidential information), and the site was browsed an average of 300 person-times daily.

(3) Integrated R&D Project on Civil System Energy Conservation Technologies

As the looming threat of global warming becomes increasingly urgent, all leading countries are devoting effort to develop energy conservation technology. Apart from industrial production and vehicular transportation, various civil systems (such as air conditioning and lighting) are major energy consumers. The NSC is consequently implementing the Integrated R&D Program on Civil System Energy Conservation Technologies, which has the three main technological goals of development of high-efficiency parts and components/performance improvement, integration of control chips and power transistors in energy-conserving design platforms, and development of comprehension electromechanical integration solutions. Taking advantage of the strengths of Taiwan's electronics industry, the program will promote electromechanical integration, encourage the development of high-efficiency machinery parts and components, encourage participation in civil industries, foster application of the IC industry's past 3C technologies in civil industries, and thereby develop key energy conservation technologies. During its first year of implementation (up to the end of September, 2010), this program had already resulted in two patents and 17 patent applications, the publication of six domestic and 39 foreign papers, the issuance of 49 domestic and 51 conference papers, and two technology transfer cases.

(4) Integrated Applied Research Project on Innovative Wireless Sensor and Network Technology

Although many countries have been devoting considerable effort to the development of ubiquitous superior living technology for many years, with regard to the key technology of wireless sensor networks (WSN), the fact that sensing node platforms have not been standardized, sensing nodes are costly (approximately NT$8,000), and users are uncertain how to use this technology have prevented widespread adoption. In order to change this situation, the NSC has implemented the Forward-

Looking Research Project on Innovative Wireless Sensor and Network Technology. Both National Taiwan University and National Tsinghua University have developed domestically-owned sensing node platforms, and it is hoped that standardization and the free provision of program code on an open source basis to academic users will make these platforms common platforms for industrial development and academic research, leading to a fall in prices to more reasonable levels.

The goal of this project is to achieve concrete results, and not simply to publish academic papers. The project team has made use of National Taiwan University's Kong Ming platform and National Tsinghua University's Octopus platform in home care, environmental monitoring, outdoor environmental monitoring, public safety, and intelligent dwelling applications. This work has lowered the technological threshold of wireless sensor network integration, enhanced the value of the wireless sensor network industry, and increased the ubiquity of applications.

The project has promoted the industrial alliance concept in order to accelerate industrial extension. Before embarking on application projects, the project team located firms willing to participate in joint R&D; these firms had to pay an "early participant fee" to obtain first right of refusal to technology transfer of R&D results.

In accordance with the project's requirement that all results be concrete, all R&D results thus far have been practical and tangible. Some R&D results are already being used in hospitals or other applications connected with everyday life. Other results have attracted many public inquiries, or have been used in prototypes close to commercialization. Among the most notable applications include the "Discharged Patient Telemedicine Care Center" used by National Taiwan University Hospital, a dynamic plant disease monitoring network, the interactive wireless "Sound Tree Sidewalk," and a black box for mountain climbers. These results have attracted great interest from companies, and negotiations concerning the possibility of technology transfer and commercial are being held.

(5) Biomedical Engineering Project on the Early Diagnosis and Treatment of Cancer

The chief goal of cancer screening is to detect persons with asymptomatic early-stage cancer, enabling them to receive treatment at an early date. The advantages of cancer screening include: (1) it facilitates early discovery, early diagnosis, and early treatment; (2) by shedding light on local cancer epidemiology, screening can provide a reliable basis for etiology research and prevention work; (3) the discovery and treatment of pre-cancerous pathologies can reduce the occurrence of cancer; (4) the discovery of high-risk groups can enable intensive follow-up of group members; and (5) screening provides opportunities for enhancing people's cancer prevention awareness. While chemotherapy and radiation therapy currently predominate among cancer treatments, such other methods as photodynamic therapy, ultrasound diathermy, heat therapy with nanoparticles, and targeted drug therapy are under development.

The Biomedical Engineering Project on the Early Diagnosis and Treatment of Cancer is drawing on biology, medicine, materials science, machinery, chemical engineering, electrical machinery, electronics, and computer technology to develop effective early diagnostic systems for cancer, allowing the most effective early treatment. This project provided funding to six subprojects. The most notable results included Chang Gung University's work on the release of large molecule drug carriers in the brain and quantitative analysis. The new technology developed in this project employs focused ultrasound in conjunction with magnetic nanoparticles to overcome the restricted permeability of the blood-brain barrier, which typically allows only small molecule drugs to enter the brain. This technology has been successfully used to enable > 200 kDa nanometer compound drugs to enter the brain. The results of this project have been published in the Proceedings of National Academy of Science of the United States of America, and the article was one of a small number of papers concerning ultrasonic technology to have been accepted by this periodical in recent years.

(6) Interdisciplinary Integrated Project on Forward-looking Intelligent Lightweight Mobile Vehicle Technology

While the world's demand for petroleum has increased dramatically over the last few years, oil reserves are rapidly being depleted, which has caused the price of oil to soar and severely affected motor vehicle demand. Responding to this situation, the leading countries are striving to develop intelligent lightweight vehicles that will meet the need for environmental protection, energy conservation, safety, comfort, and localization, and the Executive Yuan followed suit by listing the intelligent vehicle industry as deserving of policy support in its 2006 Strategic Review Board conference. Although the various types of vehicles offer convenience to society, they also impose a burden on the environment. Because of this, a key issue in the campaign to develop intelligent lightweight vehicles is achieving harmonious coexistence between people, vehicles, and the environment.

The development of intelligent lightweight vehicle systems and key technologies must focus on preliminary market analysis and conceptual design. Apart from styling, functions, and performance, such a vehicle should reflect a bold and detailed vision of life in the future. For instance, in the urban driving environment, the conceptual design of new vehicles should include ease of parking, a small turning radius, and the mobile office concept. The interdisciplinary research project on intelligent lightweight vehicles must therefore derive innovative conceptual designs after compiling and analyzing market information, and embark on forward-looking technology R&D reflecting future

**This monitoring system in the tea plantations of Pinglin Chiu is one of the results of the Integrated Applied Research Project on Innovative Wireless Sensor and Network Technology and can report signs of the harmful moth *Spodoptera litura*. This type of system can make use of National Taiwan University's Kong Ming platform or National Tsinghua University's Octopus platform, and can be used in home care, environmental monitoring, outdoor environmental monitoring, public safety, and intelligent dwelling applications. This research has lowered the technological threshold of wireless sensor network integration, enhanced the value of the wireless sensor network industry, and increased the ubiquity of wireless network applications.**

**Photo / text: Prof. Chiang Chao-ai, Department of Bio-industrial Mechatronics Engineering, National Taiwan University**

circumstances and consumers' needs.

The Interdisciplinary Integrated Project on Forward-looking Intelligent Lightweight Mobile Vehicle Technology is a joint effort involving industry, universities, and research organizations. Universities are performing early development work, sometimes in conjunction with research organizations, and R&D results are being transferred to research organizations or firms for product development, which is already getting underway. This project has successfully adopted the project management spirit and methods of the industrial sector. After the conclusion of the first year, the original 16 teams were reduced to 14 teams, which continued implementation under the three broad categories of (1) intelligent robotic wheelchairs, (2) light electric vehicles (LEVs), and (3) intelligent personal lightweight electric vehicles (IPLEV). The project's goals including the development of patentable systems or devices that can participate in international invention shows and exhibitions representing Taiwan, and transfer of R&D results to research organizations or industry. The project's first two years of implementation (to the end of November 2010) have resulted in 16 patents, 68 patent applications, the publication of six domestic and 22 foreign papers, the issuance of 54 domestic and 90 foreign seminar papers, and the implementation of numerous technology transfer cases.

**This personal lightweight electric vehicle is one of the results of development work targeting intelligent lightweight vehicle systems and key technologies. Apart from styling, functions, and performance, such a vehicle should reflect a bold and detailed vision of life in the future. For instance, in the urban driving environment, the conceptual design of new vehicles should include ease of parking, a small turning radius, and the mobile office concept. The interdisciplinary research project on intelligent lightweight vehicles must therefore derive innovative conceptual designs after compiling and analyzing market information, and embark on forward-looking technology R&D reflecting future circumstances and consumers' needs.**

**Photo / text: Prof. Chan Shih-hung, Department of Mechanical Engineering, Yuan Ze University**

**Numbers of Engineering Specific-topic Research Projects and Funding, 2010** **Units: NT$1 m**

| Item | Applications | | Approved projects | | Implemented projects | |
|---|---|---|---|---|---|---|
| | Projects | Funding | Projects | Funding | Projects | Funding |
| Electrical/mechanical/energy[1] | 3,311 | 3,007.64 | 1,677 | 1,143.10 | 2,164 | 1,537.04 |
| Chemical/materials/consumer applications[2] | 3,193 | 3,645.11 | 1,545 | 1,164.83 | 2,090 | 1,695.37 |
| Electronic/information/communications[3] | 3,556 | 4,000.08 | 1,687 | 1,190.05 | 2,294 | 1,744.26 |
| National science and technology programs[4] | 464 | 974.25 | 334 | 499.25 | 334 | 499.25 |
| Planning of innovative industrial-academic platform programs | 7 | 62.57 | 5 | 37.20 | 5 | 37.20 |
| Interdisciplinary instrument development programs | 10 | 90.49 | 8 | 43.70 | 8 | 43.70 |
| Special projects | 114 | 437.88 | 90 | 306.13 | 90 | 306.13 |
| Atomic energy and applied radiation technology | 20 | 25.58 | 13 | 10.87 | 13 | 10.87 |
| Energy science and technology | 652 | 729.38 | 280 | 207.63 | 319 | 244.84 |
| Academic technology development programs | 23 | 44.70 | 23 | 41.52 | 23 | 41.52 |
| Other | 51 | 206.44 | 31 | 80.17 | 31 | 80.17 |
| **Total** | 11,401 | 13,224.12 | 5,693 | 4,724.45 | 7,371 | 6,240.35 |

[1] Includes aviation engineering, mechanical engineering, shipbuilding engineering, electrical engineering, industrial engineering, production automation technology, control engineering, space technology, heat transmission and fluid dynamics, and marine engineering

[2] Includes materials and applied chemistry, chemical engineering, materials engineering, food engineering, civil and hydraulic engineering, environmental engineering, medical engineering, and polymer engineering.

[3] Includes electronic and information systems, telecommunications engineering, microelectronic engineering, and optoelectronic engineering

[4] Includes national science and technology programs on telecommunications, network communications, energy, and chips

**Engineering Specific-topic Research Project Manpower, 2006-2010** **Units: person-times**

| Item | | 2006 | 2007 | 2008 | 2009 | 2010[1] |
|---|---|---|---|---|---|---|
| Research personnel | Professors | 5,638 | 6,581 | 3,984 | 4,693 | 4,663 |
| | Associate professors | 5,616 | 5,788 | 2,515 | 2,899 | 2,898 |
| | Assistant professors | 4,784 | 5,074 | 2,564 | 2,881 | 2,730 |
| | Lecturers | 473 | 405 | 91 | 92 | 80 |
| | Other | 281 | 335 | 334 | 454 | 501 |
| Subtotal | | 16,792 | 18,183 | 9,488 | 11,019 | 10,872 |
| Research assistants | Full-time assistants | 304 | 268 | 256 | 430 | 379 |
| | Part-time assistants | 93 | 81 | 61 | 77 | 82 |
| | Graduate students | 20,650 | 19,959 | 20,494 | 24,019 | 23,372 |
| Subtotal | | 21,047 | 20,308 | 20,811 | 24,526 | 23,833 |
| **Total** | | 37,839 | 38,491 | 30,299 | 35,545 | 34,705 |

[1] 2010 data is for up to January 29, 2011

**Numbers and Percentage of One-year and Multi-year Engineering Specific-topic Research Projects, 2006-2010**

| Year | Total projects | One-year projects(%) | Multi-year projects(%) |
|---|---|---|---|
| 2006 | 7,076 | 4,459 （63.02） | 2,617 （39.98） |
| 2007 | 6,703 | 3,736 （55.74） | 2,967 （44.26） |
| 2008 | 6,773 | 3,625 （53.52） | 3,148 （47.22） |
| 2009 | 7,411 | 4,080 （55.05） | 3,331 （44.95） |
| 2010 | 5,947 | 4,128 （69.41） | 1,819 （30.59） |

Note: Academic collaboration projects in applied technology projects have been included among engineering projects starting in 2008.

### 3. Life Science

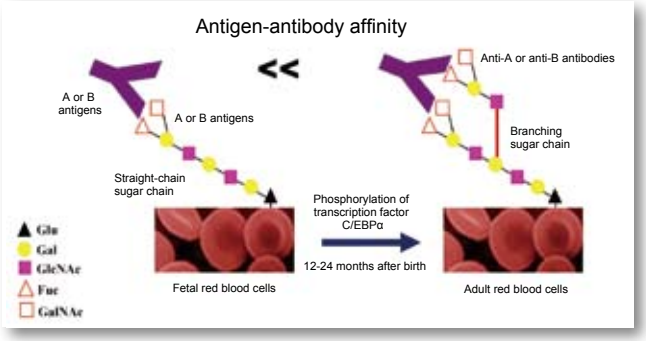
Life science encompasses 14 fields within the three main disciplines of biology, agriculture, and medicine. The NSC's primary mission in life science is to plan, implement, manage, and assess research and development projects in these fields, to improve the quality of research in life science and increase R&D capacity, to train outstanding research personnel, and to promote the formation of research teams. We aim to create a superior academic environment and provide effective research funding, to promote the pursuit of excellence, to foster technological interchange and cooperation, and to encourage the development of biotechnology. The following were among some of the most notable research results of the year:

(1) Biology

Research on developmental biology used the nematode *C. Elegans* as an animal model to study the mechanism of clearing dead cells. This project discovered for the first time that the membrane protein integrin can identify dead cells, and thus made a major academic contribution to cell biology and developmental biology.

Research in cell biology used fruit flies and mammalian cells to investigate the mechanism of cell autophagy. The phenomenon of cell autophagy is used by living organisms to eliminate living matter that is damaged or not needed, and is particularly important to cellular survival when cells are in a state of starvation. This study made breakthroughs in our understanding of how cells' autophagy organelles form and their key molecular mechanisms.

Research on the molecular regulation mechanism of selective cell autophagy using a yeast model has been significantly valuable for treatment strategies to abnormal cell autophagy function induced human diseases, such as cancer and neural degeneration.




**The phosphorylation status of transcription factor C/EBPα determines the formation of branching structure of straight glycans on the newborn's red blood cell surface. This event greatly lifts the antigenic potency of ABO blood antigen as well as other carbohydrates antigens.**

**Image/text: Prof. Lung-Chih Yu, Institute of Biochemical Sciences, National Taiwan University**

On the adult's red blood cell surface, branched poly-LacNAc chains are often greatly expressed, while the poly-LacNAc chains expressed on the foetus or neotate's red blood cell surface are straight. The fact that straight repeats of poly-LacNAc chains greatly lower the antigenic potency of ABO blood antigen contributes a defensive mechanism by which the foetuses and neonates are not suffered from a hemolytic disease induced from the ABO incompatibility between the mother and the foetus. Research using the differentiation of blood cell lines and blood stem cells as a methodological model proved that, during the red blood cell differentiation, the formation of the branched poly-LacNAc is regulated by the phosphorylation of the transcription factor C/EBPα. This study shed considerable light on the molecular mechanism of hemolytic disease caused by incompatibility between fetal and mother's ABO blood types.

Research on the ecological genomics of wild species in East Asia focused on such species as Arabidopsis, fruit flies, and grass lizards, acquired the newest genomic technologies and concepts, and analyzed the evolution of characteristics of wild species and their adaptations. This study made influential contributions to research on model species by adopting selection methods for numerous adaptive genes.

(2) Agriculture

Combining monoclonal antibodies with gold nanoparticles to form gold nanoparticle-based antibody probes, a project has developed immunochromatographic strips for rapid detection of Ochratoxin A. Using this strip to examine the Ochratoxin A content in coffee allows on-site testing for Ochratoxin A without instruments, hence it will be very applicable in the area of food safety.

Research using cellular and in vivo models investigated the protective effects of flavonoid and phenolic compounds against damage induced in organisms by advanced glycation end-products (AGEs) and their possible pathways. The results indicated that polyphenols in food possess the ability to block oxidative stress and inflammation caused by AGEs.

A project found that porcine mammary epithelial cells can produce recombinant proteins with bioactivity for medical uses. These cells can be cultured in hollow fiber bundles for long-term, continuous production of desired proteins. The artificial mammary gland tissue bioreactor system developed in this project can provide a novel platform to produce medical recombinant proteins and possesses significant commercial potential.

Researchers discovered for the first time that many wild fish from the seas around Taiwan carry the SJNNV genotype,

and SJNNV viral strains from Taiwan's wild fish differ from those strains of infected fish from Japan and Europe. This finding represents a very important advance in our understanding of the distribution and transmission of the nervous necrosis virus in wild and farmed fish around the world.

Conventional analytical instruments cannot readily be used to perform real-time field testing of organophosphate pesticide residues or other substances with physiological functions in tea samples. A research project successfully used amperometry in conjunction with a capillary electrophoresis chip containing conductivity sensors to develop a "dual-channel capillary electrophoresis chip". This enables simultaneous isolation and detection of substances in tea via dual electrophoresis channels. The chip will facilitate the qualitative and quantitative analysis of unknown substances, allowing fast and real-time analysis of tea in the field.

Researchers have established self-organizing radial basis neural networks to estimate fish biodiversity. The result shows that this model not only can categorize the stream flow data but also provides quick, efficient, and precise estimation of biodiversity.

Research demonstrated that a 1000-fold dilution of total protein extracts from *Alternaria brassicicola* and *A. Alternate* can effectively prevent rhizoctoniosis of sweet peppers and Chinese cabbage in seedling stage, and anthracnose of cucumber and Chinese cabbage. This project proved that fungal proteins can be used in the development of plant protectants.

(3) Basic medicine

A research project performed in-depth study of the possible mechanisms by which proteins with abnormally stacked cytoskeletons may induce cytotoxicity and neural degeneration. This project used specific protein kinase inhibitors to suppress hyperphosphorylation of cytoskeletons within a neuronal model. It could be a potential strategy for slowing down the neuronal degeneration by these candidate inhibitors. The researchers are currently testing these potential drugs in animal models of neuronal degeneration. The partial effectiveness of treatment has been observed in some aged animals. The results of this project could be potentially applied in the clinical treatment for ameliorating neurodegenerative diseases.

A project involving the transgenic rescue of knockout mice investigated the physiological significance of the interaction between Mcl-1, Tom70, and TCTP. The transgene rescued mice created in this project can serve as an animal model for a type of specific congenital heart disease in humans. In a normal heart, the aorta and pulmonary artery are connected to the left and right ventricles, respectively. This study discovered that the aorta and pulmonary artery were both connected to the right ventricle in embryonic hearts rescued with the Mcl-1 mutant protein that failed to interact with Tom70. Such phenotype is very similar to one congenital heart disease named "double outlet right ventricle", suggesting that Mcl-1 plays an important role in the developmental process of heart. Mcl-1 may thus serve as a new target for a novel therapeutical strategy for specific types of congenital heart diseases.

Investigation on the control of T cell activation and apoptosis by phosphorylation of the adaptor proteins paxillin and ezrin. Results demonstrate the formation of activated complex by the phosphorylated paxillin and the cellular events mediated by this complex. These results facilitate our understanding on the physiological functions of adaptor proteins in signal transduction. The findings of this project will likely be applied to regulation of T cell immune function, through control of T cell activation to prevent or treat immune-related malfunctions such as infections, cancer, organ rejection, and autoimmune diseases.

Although inflammation plays an important role in maintaining the body's physiological functions, inappropriate inflammation is closely linked with many diseases. A research project discovered that: (1) DSM-RX78 is a phosphodiesterase 4 inhibitor with a novel chemical structure, and, via control of neutrophil activation, can effectively inhibit lung damage in rodents caused by hemorrhagic shock; (2) a new benzoxazinone derivative is a neutrophil elastase inhibitor, and it is also able to ease lung damage in rodents caused by hemorrhagic shock. Apart from shedding light on the pharmacodynamics and pharmacological mechanisms of neutrophil regulation by these novel compounds, this work will also facilitate the development of drugs to treat diseases characterized by inflammation disorders.

(4) Clinical medicine

Since alpha-fetal proteins and des-$\gamma$-carboxyprothrombin (DCP) are inadequate tools for the early diagnosis of liver cancer, there is a need to develop new liver cancer markers. A research project employed proteomics analysis to find glycoproteins connected with liver cancer. Thus far the project has successfully employed agglutinin (lectin) affinity chromatography to isolate glycoproteins from liver tissue, and used two-dimensional electrophoresis to separate the various proteins. The researchers have also used semi-quantitative methods to compare relevant proteins from individuals in a control group with those from patients who have undergone surgery for liver cancer to determine differences in the expression of glycoproteins. The project has identified several promising glycoproteins, and plans to confirm these glycoproteins.

A project aimed to generate sodium bicarbonate cotransporter 1 (NBC1) W516X knock-in mice to represent human disease caused by NBC1 W516X mutation for the elucidation of this nonsense mutation and its rescue strategy. Results indicate that nonsense-mediated mRNA decay (NMD) is involved in the defective transcription and translation of nonsense NBC1 W516X, leading to elimination of NBC1 function. Homozygous NBC1 W516X mice exhibit the typical phenotype of human pRTA but with early lethality and other organ abnormalities, which can be significantly ameliorated by alkali therapy but not by newly-developed NMD inhibtor (PTC 124).

The carcinogenic mechanism of breast cancer in Taiwan may differ from that of breast cancer in Western countries. A research project revealed that MKP-1 expression was increased upon treatment with estrogen or its antagonist, tamoxifen, in breast cancer cells, MCF-7. In contrast, MKP-1 expression was not significantly altered in estrogen receptor (ER)-negative breast cancer cells, MDA-MB-231, upon the same treatment. The researchers concluded that high expression of MKP-1 protein might improve patient survival and participate in the anti-cancer activity of tamoxifen via an ER-dependent pathway. Thus, MKP-1 may have a tumor suppressing role or function in Taiwanese breast cancer. This research achievement provides clinicians a novel prognostic factor and a new indication for therapeutic strategy. Nevertheless, the underlying mechanisms of tamoxifen-modulated MKP-1 expression via ER require to be further clarified.

Research employing single cells as its experimental basis developed a genetic diagnostic technique on single cells, and applied its findings to prenatal diagnosis and pre-embryo implantation genetic diagnosis. The study relied on blastomere biopsy and blastocyst biopsy to develop genetic diagnosis techniques for tiny numbers of cells. The project used whole genome amplification, minisequencing, and melting curve analysis to create a fast and accurate methodology for pre-implementation genetic diagnosis, and applied this method to testing for thalassemia, hereditary hearing loss, neurofibromatosis type I, Duchenne muscular dystrophy, and spinal muscular atrophy. In addition, to further extend the applications of this method, the researchers also used it to perform human leukocyte antigen (HLA) genotyping from a brother and sister with beta thalassemia; after transferring HLA-identical embryo, the researchers showed that stem cells obtained from umbilical blood or bone marrow after birth could be transplanted to treat the beta thalassemia. The results of this research project will facilitate the development of genetic diagnostic methods on single cells, which can be used in non-invasive prenatal genetic diagnosis.

A project investigated the feasibility of using gene polymorphisms and plasma concentration of the EB virus DNA as screening markers for nasopharyngeal cancer. This research found that the presence of the EB virus DNA in plasma can indeed be used as a screening technique for nasopharyngeal cancer in public health check-ups, and this method's sensitivity and specificity are much better than those of the currently-used anti-EB virus antibody method. The results of this project will pave the way to potential applications developed in cooperation with industry, such as easy-to-use testing kits that can be used by health check-up centers or hospitals. Even more importantly, apart from commercial value, the project's results will help boost the nasopharyngeal cancer cure rate and contribute to the control of this cancer.

**Numbers of Life Science Specific-topic Research Projects and Funding, 2010** **Units: NT$1 million**

| Item | Applications | | Approved | | Implemented | |
|---|---|---|---|---|---|---|
| | Projects | Funding | Projects | Funding | Projects | Funding |
| Medicine | 3,463 | 9,387.83 | 1,548 | 2,145.16 | 3,145 | 3,991.74 |
| Biology | 451 | 1,297.39 | 186 | 257.99 | 434 | 581.11 |
| Agricultural science | 638 | 1,397.75 | 267 | 318.97 | 645 | 784.44 |
| Biotechnology | 150 | 651.78 | 144 | 437.08 | 144 | 437.08 |
| Special projects and other | 299 | 1,200.09 | 188 | 602.29 | 221 | 665.87 |
| **Total** | 5,001 | 13,934.84 | 2,333 | 3,761.49 | 4,589 | 6,460.24 |

**Life Science Specific-topic Research Project Manpower, 2006-2010** **Units: person-times**

| Item | | 2006 | 2007 | 2008 | 2009 | 2010[1] |
|---|---|---|---|---|---|---|
| Research personnel | Professors | 3,318 | 4,010 | 2,210 | 2,588 | 2,822 |
| | Associate professors | 2,350 | 2,623 | 1,140 | 1,382 | 1,568 |
| | Assistant professors | 2,400 | 2,821 | 1,395 | 1,664 | 1,767 |
| | Lecturers | 393 | 486 | 98 | 127 | 133 |
| | Other | 2,670 | 3,100 | 2,129 | 2,355 | 2,634 |
| Subtotal | | 11,131 | 13,040 | 6,972 | 8,116 | 8,924 |
| Research assistants | Full-time assistants | 1,860 | 2,146 | 2,275 | 2,551 | 2,813 |
| | Part-time assistants | 94 | 59 | 65 | 73 | 58 |
| | Graduate students | 5,183 | 5,425 | 5,417 | 6,055 | 6,395 |
| Subtotal | | 7,137 | 7,630 | 7,757 | 8,679 | 9,266 |
| **Total** | | 18,268 | 20,670 | 14,729 | 16,795 | 18,190 |

[1] 2010 data is to January 29, 2011

**Numbers and Percentage of One-year and Multi-year Life Science Specific-topic Research Projects, 2006-2010**

| Year | Total projects | One-year projects (%) | Multi-year projects (%) |
|---|---|---|---|
| 2006 | 3,805 | 1,877 (49.59) | 1,918 (50.41) |
| 2007 | 3,814 | 1,237 (32.43) | 2,577 (67.57) |
| 2008 | 3,826 | 618 (16.15) | 3,208 (83.85) |
| 2009 | 4,268 | 577 (13.52) | 3,691 (86.48) |
| 2010 | 4,589 | 640 (13.95) | 3,949 (86.05) |

**4. Humanities and Social Sciences**

The humanities and social sciences encompass 17 disciplines in the three major areas of the humanities (literature, history, philosophy), the social sciences (law, political science, sociology, education, and psychology), and management/economics, and also include the operations of the Humanities Research Center and Social Sciences Research Center. The following were among some of the most significant research results, research projects, and database compilation results during the year:

(1) Literature, history, and philosophy

The field of Chinese literature included the holding of the "2003-2008 Research Results Announcement Conference on The categories of Etymology, Phonology, and Semantics". The categories of Etymology, Phonology, and Semantics have great importance in both traditional Chinese academic research and modern academic thinking. The increased sharing of results in recent years has helped improve academic standards and expanded the influence of the field. In the field of foreign literature, apart from ongoing research on foreign literature, interdisciplinary, inter-medium, and intercultural research was performed in such areas as comparative literature, literary theory, gender studies, cinema studies, and cultural studies, including research on Chinese-language literature conducted under the framework of comparative literature or world literature. The ranking of periodicals concerning foreign literature was completed, and the "2002-2009 Foreign Literature Research Project Results Announcement Conference" held. In the field of history, the "Workshop on Recent Minnan Culture: Field Studies and Literature" involved cooperation between students and teachers in China and Taiwan, and performed fact-finding work on the Kinmen and along the coast of China's Fujian Province. This highly-effective workshop employed field surveys and interpretation of folk literature to help budding scholars break through the customary reliance on textual materials in research on Taiwanese history, enabling learners to embark on field studies and interpret literature at historical sites. In linguistics, the "Linguistics Excellence Camp: Minnan Research" was held to encourage Taiwanese academics to take advantage of their extensive research in the Minnan language to broaden the perspectives of young scholars studying or interesting in studying this branch of Chinese. Domestic and foreign scholars in relevant areas were invited to lecture, teach seminars, and hold workshops at this event, which gave a significant boost to research standards in linguistics. In philosophy, the NSC promoted research on comparative religious experience in Asia and the manpower training programs on the following subjects: Song-Ming neo-Confucianism, hermeneutics and phenomenology, Buddhist epistemology, young scholars training program, and contemporary normative philosophy research—philosophy manpower improvement and training program. In art, the ranking of periodicals was completed, and the "Integrated Project on Application of Integrated Innovative Service Design to the Cultural Creativity Industry" was implemented to fuse culture with the aesthetic economy, develop lifestyle industries, promote the merger of culture, art, and technology, apply the aesthetic economy to foster innovation in various industries, and stimulate emerging industries.

(2) Law, political science, sociology, education, and psychology

In law, the project "Fair Trade Act: Analysis of Practice and Administrative Court Decisions" issued a summary research report analyzing all relevant administrative court decisions concerning the Fair Trade Act during the 19-year period from the Act's promulgation on February 4, 1992 till December 31, 2010. In political science, the "Democratic Visions before the Age of Democracy" project performed classical textual analysis; the results of the project explain the inner universal tendency of democracy at the level of "political vision," and propose a viewpoint different from both the normative perspective and the views of empirical history. In sociology, the project "Manufacturing Loyalty: A Comparison of the Political Mobilization of Labor in Taiwan, Japan, and China" compared the rise and fall of political activism among labor in China, Japan, and Taiwan, and investigated how the working class responded to top-down ideological spoon-feeding and gave rise to political loyalty; the design of this project aimed at uncovering the ultimate influence of workers' resistance movements. In anthropology, the project "Building Characters: Work, Local Culture, and Individualism in the Cultural Creativity Industries of Taiwan, Hong Kong, and China" used ethnographical methods to investigate the work situations and everyday lives of workers in the character product industries of Taiwan, Hong Kong, and China. In education, the project "Improving the Basic Academic Skills of Underprivileged Students in Isolated Areas: Understanding and Intervention for underarchievers" has worked to improve education for underprivileged children over the course of several years, and has accumulated many academic and practical results; the project provides remedial language instruction to schoolchildren with low academic achievement, conducts early intervention before school age, and offers education to foreign spouses. With regard to issue of "turning failing schools around," workers have sought to understand and resolve the problem of underachievers living in isolated areas using a variety of approaches, such as remedial instruction in language and other subjects and attention to cognitive behavior and psychological aspects. In psychology, the project "Traumatic Memories, Ego State, Recovery Ability, and Post-Traumatic Stress Disorder" developed self-defining memory tasks, a self-defining memory rating sheet, and self-questionnaire for Taiwan; this project also gained an understanding of the influence of traumatic auto accident memories on ego state and the origin, continuation, deterioration, and decline of post-traumatic stress disorder, and pondered possible clinical interventions aimed at helping traumatized auto accident survivors to improve their quality of life. The regional studies project "Planning the Urban Architectural Environment and Selecting Design Programs" investigated the selection of urban renewal programs, and explored issues such as site selection and assessment; this project can provide decision-makers (in either the public or private sector) with cost and effectiveness tools needed to find the best program, and ensure that resources are allocated in a reasonable manner.

(3) Economics and management

Economics and management include basic academic research, industry-academic collaboration projects, and international collaboration projects in various areas connected with economics and management studies, including both theoretical and empirical aspects. Integrated projects conducted this year included the following: The integrated project on "Intellectual Capital" has already been underway for more than five years and has completed two phases. The participants in this project include scholars specializing in finance, economics, accounting, human resources, planning, and sociology, who are

investigating intellectual capital-related issues from various angles in an effort to create a high added value industry environment for Taiwan. This integrated project has established an academic community after bringing together intellectual capital scholars and researchers, and is continuing to investigate this subject of great importance to Taiwan's future development. Apart from achieving a high level of interaction within the community, the second phase of the project also resulted in many collaborations and outputs in the field of intellectual capital, and the participating scholars also drafted relevant courses at the schools where they teach, enabling them to pass on their research results and direct graduate students toward relevant research topics. The research promote for the third phase will encompass the levels of country, organization, team, and individual, and will focus on intellectual capital research topics including human capital, structural capital, social capital, innovation capital, antecedents, and outcome variables. The project "Behavioral Model and Performance of Financial Information Brokers, and Earnings and Stock Price Forecasts" reflected the importance that the financial media and academic researchers place on the actions of financial information brokers and their performance, and also acknowledged the influence that research reports issued by financial brokers have on managers and internal company personnel. In the wake of the global financial crisis and recession, investors and academic researchers are paying even closer attention to the effect of industrial and macroeconomic factors on stock prices, and are seeking ways of using international industry information to construct profitable investment portfolios. This project consequently brought together financial information brokers with scholars involved in forecasting of earnings and stock prices to investigate the behavior of financial brokers, the influence of financial information brokers sign managers and company personnel, and factors affecting earnings and stock price forecasts. In addition, activities in the field of economics and management also included the holding of the "Workshop on Ph.D. Student Dissertation Proposals and Research Methods" and "Workshop on Academic Trends in Information Management," at which first-rate invited scholars provided guidance to Ph.D. students and young scholars involved in research, and shared their research experience and recent trends in relevant fields; these workshops also enabled domestic scholars and Ph.D. students to establish international collaborative relationships with prominent master academic. In addition, another round of grading and ranking international periodicals was performed in the field of finance, providing reference information to researchers interested in submitting manuscripts or conducting performance evaluations.

The following are some of the main results of research projects actively planned and implemented by the NSC:

(1) NSC-promoted projects

a. Research on aging

Demographic aging is a multifaceted process. This project is performing basic research on the various needs of an aging society, including the aspects of economic security, health, social care, living arrangements and housing, employment, education, transportation, communications, and recreation, and has established relevant indicators and databases concerning demographic aging in Taiwan. The second phase of this project will perform "community-based action research" in two communities located in northern and southern Taiwan respectively. The results of this project will help the government to formulate relevant policies, and will also form a basis for the development of related technologies, services, and industries, including the R&D, development, manufacturing, and marketing of products for seniors.

b. Comparative Study of Asian Consumer Technology, Society, and Culture

This project addressed the following three major research categories and key issues connected with Taiwan and other countries or areas in Asia with similar social problems and development experiences: (1) Reflections on technology and the humanities: The incorporation of technology in everyday life and reflections on technology by Asian literary scholars. (2) Social and cultural change: Multinational mobility, Asian religions, the fashion and consumer markets, tourism, and the cultural creativity industry. (3) Livelihood and public issues in Asia: The problems of aging, housing, poverty, falling birth rate, higher education, and healthcare supply and demand. This project has forged links between domestic and foreign scholars in the humanities, social sciences, economics, management, environmental studies, and interdisciplinary studies, establishing a diversified, inter-regional, mutually-supporting research network and intelligence platform. The project is examining how Taiwan should response to future cultural, social, and knowledge changes, how Taiwan can stay at the forefront of Asian and international trends, gaining an understand of the possible challenges that Taiwan may face in the future, and drafting response mechanisms and strategies. The project provided funding to eight integrated project research teams during 2009 and 2010.

c. Industry-Academic Bridge Study of Business Management

This project is focusing the research energies of academic scholars on services and products with market potential, providing industry with effective solutions to practical problems, implementing the "Business Management Industry-Academic Bridge Research Center Forerunner Project," and accomplishing the four tasks of "providing relevant services assisting academic personnel to commercialize research results," "helping teams with commercially competitive proposals to engage in industrial development," "analyzing practical problems involving management and sales, etc. encountered by industry," and "providing effective solutions to practical problems faced by industry." The project is encouraging business management scholars to actively participate in industry-academic collaborative projects, and seeks to couple the academic community's R&D capabilities with the needs of industry in order to boost Taiwan's industrial competitiveness.

(2) Compilation of databases

In order to facilitate academic research and establish a comprehensive body of academic data, the NSC is promoting the following long-term database projects:

a. Taiwan Social Change Survey Database

The "Social Change Survey" is currently conducting the first survey during the program's 6th stage, and plans call for five surveys during the coming five years, during which time it will collect ten sets of data. All survey data is made available for free public access a year after preliminary analysis. This data is chiefly browsed and downloaded for use in domestic academic survey research, and a growing number of published papers are based on this data. Furthermore, the quantity and quality papers using the data published in leading international academic

journals has risen significantly within the last five years. The trend toward publishing papers in foreign periodicals has helped earn international academic recognition for the Social Change Survey.

b. Taiwan Education Long-term Tracking Database

This project is a follow-up tracking survey to the Taiwan Education Panel Survey (TEPS), and is also known as TEPS-B (Taiwan Education Panel Survey and Beyond). The project conducted a telephone survey of all high school/vocational high school/five-year junior college student respondents to TEPS surveys from the first survey in 2001 to the third survey in 2005, and also performed face- to-face interviews with approximately 4,200 TEPS-B respondents. This project tracked two samples, which consisted of persons entering the labor market and those pursuing higher education. As a consequence, the research questions and theoretical analysis in the TEPS-B project focused on the quality of universities in the wake of the expansion of Taiwan's higher education system, the effect of department selection on occupational performance after entering the labor market, and gender differences in department selection and workplace performance.

c. Survey Research Data Archive

This project has established data collection and data error-checking procedures and systems, and established and maintains a Chinese / English web site (http://srda.sinica.edu.tw/). A total of 34 issues of the quarterly *Survey Research Data Archive Bulletin* and 147 issues of a biweekly e-bulletin have been published. The survey's data processing and error-checking team collected a total of 754 items of survey data available for public use between 1998 and 2008, and also collected other data (91 data items from before 1997, 30 items from the public version of TEPS, and 64 items from the restricted version of TEPS). The project currently has at least 939 data items available to applicants from the academic community.

d. Humanities and social sciences research book assistance project, second foreign language database, and research database

The purpose of this project is to increase the number of research books and equipment items available to the humanities and social sciences, assist relevant schools and departments to establish their own distinct research libraries, and promote the long-term development and overall performance of academic research in the humanities and social sciences. This five-year project seeks to purchase books in research areas that are forward-looking, possess regional relevance, are interdisciplinary, and will yield a high level of synergy in the humanities and social sciences. The project purchases more 100,000 books for research use each year, and is establishing core collections of research books in various fields of study. In addition, the second foreign language research resource project completed analysis of domestic research communities and clusters, assembled free online research resources concerning the foregoing languages, and established an integrated web site laid out according to academic field and serving domestic humanities and social sciences research communities. Finally, research databases purchased by the NSC were publicized and made available for domestic academic use.

e. Special Education Long-term Tracking Database

The Special Education Long-term Tracking Database project completed a first round of survey work focusing on preschool and elementary school fourth-grade students in 2008, and also completed a second round of survey work focusing on junior high school students during 2009. The project continued a first survey of high school/vocational high school students and a survey of the state of special education in counties (cities) during 2010, and also performed data error-checking and analysis, and made preparations for surveys in 2011. Apart from analyzing the state of domestic special education and its development trends, the goal of this database is also to provide data to researchers performing analysis of various topics in the field of special education and other relevant areas. The NSC expects that this database will spur the improvement of special education policy and implementation, boost the quality of domestic special education, and stimulate the achievement of a greater quantity of even more systematic research results.

**Numbers of Humanities and Social Science Specific-topic Research Projects and Funding, 2010** **Units: NT$1 m**

| Item | Applications | | Approved | | Implemented | |
|---|---|---|---|---|---|---|
| | Projects | Funding | Projects | Funding | Projects | Funding |
| Literature / history / philosophy | 1,832 | 992.15 | 849 | 420.08 | 1,091 | 570.79 |
| Law/political science / sociology / education / psychology | 2,271 | 1,693.70 | 932 | 538.17 | 1,252 | 781.92 |
| Management/economics | 3,252 | 2,098.53 | 1,453 | 771.27 | 1,802 | 1,010.99 |
| Art, physical fitness, library science | 971 | 709.92 | 355 | 188.79 | 406 | 222.92 |
| National digital archives and e-learning programs | 298 | 689.93 | 144 | 244.51 | 144 | 244.51 |
| Regional studies and geography, gender research, genetic technology, etc. | 731 | 531.62 | 304 | 169.05 | 348 | 203.90 |
| Other | 13 | 41.60 | 1 | 0.40 | 1 | 0.40 |
| **Total** | 9,368 | 6,757.45 | 4,038 | 2,332.27 | 5,044 | 3,035.43 |

**Humanities and Social Science Specific-topic Research Project Manpower, 2006-2010** **Units: person-times**

| Item | | 2006 | 2007 | 2008 | 2009 | 2010[1] |
|---|---|---|---|---|---|---|
| Research personnel | Professors | 2,442 | 3,110 | 1,598 | 1,677 | 1,821 |
| | Associate professors | 3,229 | 3,644 | 1,479 | 1,572 | 1,805 |
| | Assistant professors | 3,478 | 4,274 | 1,930 | 2,064 | 2,303 |
| | Lecturers | 529 | 518 | 101 | 104 | 72 |
| | Other | 200 | 200 | 370 | 434 | 434 |
| Subtotal | | 9,878 | 11,746 | 5,478 | 5,851 | 6,435 |
| Research assistants | Full-time assistants | 525 | 731 | 567 | 805 | 811 |
| | Part-time assistants | 296 | 291 | 266 | 308 | 310 |
| | Graduate students | 6,636 | 7,354 | 8,180 | 8,853 | 9,940 |
| Subtotal | | 7,457 | 8,376 | 9,013 | 9,966 | 11,061 |
| **Total** | | 17,335 | 20,122 | 14,491 | 15,817 | 17,496 |

[1] 2010 data is to January 29, 2011

**Numbers and Percentage of One-year and Multi-year Humanities and Social Science Specific-topic Research Projects, 2006-2010**

| Year | Total projects | One-year projects (%) | Multi-year projects (%) |
|---|---|---|---|
| 2006 | 3,636 | 2,794（76.84） | 842（23.16） |
| 2007 | 3,989 | 2,382（59.71） | 1,607（40.29） |
| 2008 | 4,378 | 2,378（54.32） | 2,000（45.68） |
| 2009 | 4,594 | 2,686（58.47） | 1,908（41.53） |
| 2010 | 3,898 | 2,995（76.83） | 903（23.17） |

### 5. Science Education

The NSC promotes science education research in order to improve the academic standards of science education, enhance the quality of science education, and increase the efficiency of instruction. Science education research should seek to resolve current problems in science education, respond to social changes and global environmental trends, and should actively realize research results in the form of practical applications. The following were among some of the most significant research results of the year:

(1) Mathematics education

A project on the use of e-learning to help fifth- and sixth-grade elementary school students to develop number sense developed instructional tools incorporated technology and animated learning activities, helping teachers to teach and students to cultivate number sense competence. This project completed ten number sense digital animated activities and five mathematics instructional tools on fractions. Eight of the digital animated activities are already being used in teaching and learning experiments, and have yielded excellent results. The findings of this project have been published in the *Journal of Educational Technology and Society*.

Longitudinal Study on Cognitive Neural Development of Statistical Inference － Perceiving Uncertainty: This project is a subproject of the "Statistics Education: Manpower Cultivation and Information Integration" project. This project observed and studied key elements of statistical inference in kindergarten and schoolchildren, including the development of cognition of uncertainty, and performed a comparative experiment based on cognitive-neural development. This project's analysis of differences in the development of cognition of uncertainty and certainty will facilitate the design of modern statistical qualifications, educational strategies, training classes, and theoretical or applied research in statistical cognition.

Investigation of Middle School Mathematics Teachers' Statistics Teaching Skills: This project, which is a subproject of the "Statistics Education: Manpower Cultivation and Information Integration," achieved: (1) The finding that mathematics teachers constructing counter-examples when comparing two data distributions employed simplification of categories, fixing of frequency, and adjustment of categories as their chief strategies; the difference between these strategies and the construction of counter-examples in mathematics is that there are no obvious questions in statistics. (2) Testing goals were drafted for the subconcept of confidence interval. (3) Focus group mathematics instructors felt that the main difficulties encountered in the teaching of statistics included insufficient knowledge and experience, unfamiliarity with auxiliary instructional tools or difficulty obtaining such tools, difficulty coordinating theoretical and empirical aspects, the restriction on use of calculators in tests, and inconsistent definition of statistical formulas.

Eye Movements in the Reading of Mathematical Text: In eye movement tracking instrument was used to investigate the integration of different modes of information, including mathematics vocabulary, symbols, graphics, and tables, during the course of reading. This project enriched mathematics reading theory, and will provide guidance for the design of mathematics texts and mathematics curricula. The project's findings indicate that university students take from twice to five times as long reading geometric proofs than science texts of similar length, have a lower skipping rate, focus close to three times on each geometric term, and spend more than 1,000 millisecond focusing on each piece of important information. These results indicate that the geometric proofs from high school teaching materials were quite difficult for university students. Although graphics play an important role in geometry texts, more than 98% of the subjects read text before diagrams. In the case of the descriptive captions accompanying geometric diagrams, readers spent 1.7 times as long reading text as looking at the graphics. However, these subjects spent roughly as much time reading text and looking at graphics in questions concerning geometric proofs, showing that geometric diagrams play an important role in the understanding of proofs.

(2) Science education

Role of Internet Self Efficacy in Learning: This project was centered on that the concept of "Internet self efficacy," investigated the relationship between Internet self efficacy and other variables (such as learners' acceptance of technology,

online learning environment preferences, and learning strategies, and examined the influence of Internet self efficacy on instructors' teaching practice and learners' learning results. The project consists of four subprojects investigating the following topics: (1) the effect of teachers' Internet self efficacy on adoption of information technology in teaching; (2) the relationship between Internet self efficacy, preference for a constructionist online environment, and online learning strategy; (3) Internet self efficacy among the middle-aged and elderly; and (4) the relationship between Internet self efficacy, technology acceptance, and learning effectiveness among employees receiving training at networked companies. After performing basic research on Taiwanese online learners in different age groups (including high school students, university students, company employees, and seniors), the project was able to develop a localized theoretical framework of learners' Internet self efficacy.

Students' Multivariate Reasoning and Learning Engagement in an Online Science Learning Environment: Engagement is considered an important aspect of allowing prediction of student learning performance, and science reasoning is a major goal of science learning. This project seeks to: (1) Employ a thorough review of the literature to understand the nature of multivariate reasoning in science. (2) Investigate students' learning engagement and multivariate reasoning in an online science learning environment. (3) Examine the role played by technological tools in support of students' learning engagement and multivariate reasoning. The project will attempt to clarify the design of online learning environments, elucidate the relationship between learning engagement and multivariate reasoning, help science educators to understand the nature of multivariate reasoning, and enrich the theoretical framework concerning online technology and science learning.

Investigating the Interplay of History of Science, Aesthetic Understanding and Argumentation in Science: This project used methods including the provision of supplementary teaching materials concerning the history of science, training of teachers to employ aesthetic understanding to boost students' interest in science, and encouragement of student participation in group discussions to investigate the development of argumentation ability in high school students and the growth of teachers' professional skills.

Instructional Planning and Implementation for the Integration of Culture and Science: This project is a subproject of the integrated project "Investigation and Application of Underlying Scientific Knowledge in Indigenous Cultures." The goal of the project is to develop instructional theory and the learning theory fusing culture and science, and create science teaching sources, teaching materials, teaching tools, and activities consistent with the fusion of culture and science. The project has focused on a different people during each year, and performed data collection and content analysis concerning the people's lifestyle and culture. Research aspects include: (1) Analysis of the indigenous peoples' cultures and scientific concepts; (2) cultural sources and the science education perspectives of science, technology, society, and the environment (STSE); and (3) cultural source material and non-standard teaching and learning activities. Within the overall framework of the integrated project, this subproject has analyzed indigenous cultures in conjunction with other subprojects, interpreted the cultures' scientific knowledge, scientific concepts, and technological applications, developed popular science education scenarios possessing cultural substance and renewing traditional cultures, and stimulating learners' (who include students, teachers, and members of the public) interest in science learning and cultural transmission. The project is relying on the promotion of popular science education combining culture and science to enhance indigenous students' interest in science and learning performance, and is also providing teachers with new instructional options. This project is thus fulfilling the goal of rooting science deeply in life and culture in the White Paper on Science Education. The project web site is http://b001.ecebest.nttu.edu.tw/front/bin/home.phtml.

Development of Genetic Teaching Materials with Diverse Viewpoints to Promote High School Students' Learning of Genetics Concepts: This project developed a set of extracurricular teaching materials, instructional methods, and assessment tools to supplement genetics units in high school life science classes. The goal of the project is to enhance students' knowledge of genetics concepts, destroy myths concerning genetic determinism, and promote understanding of the nature of biological knowledge. The project's research content encompasses (1) conceptual research on genetics-related myths; (2) development of teaching materials, instructional methods, and assessment tools; and (3) on-site instruction to assess the effectiveness of teaching methods and instructional materials.

(3) Information education

Design and Experimentation of Scenario Examples in One-To-One Technology Enhanced Classroom: With the emergence of an increasing number of one-to-one technologies, how to adopt and apply one-to-one learning technologies in the classroom has become an important issue. This project proposed two learning systems as examples one-to-one digital classroom learning scenarios, allowing investigation of how technology can improve the learning process. One of the learning systems, a computer-aided free writing system incorporating a "large volume reading" instructional strategy, was employed to improve learners' attitude toward writing and encourage thinking about writing. The other learning system, a mathematics calculation question and answer game employing a "non-identical challenge strategy," can appropriately adjust learners' self-awareness performance in a competitive environment. The results of this experiment showed that learners using the computer-aided free writing system acquired an improved attitude toward writing, gained confidence with regard to writing, and became more willing to participate in writing activities. In the case of the mathematics calculation question and answer game, while low-achievement learners often abandon learning in the face of too many failures and frustrations, the non-identical challenge strategy increased the opportunity for low-achievement learners to win the competitive game, giving them greater experience of success and boosting their willingness to take on subsequent challenges.

Assessment of Early Reading and Writing Performance when a Mobile Device is Used to Support Early English Writing for English as a Foreign Language (EFL): The careful planning of writing skills and writing processes can provide children with effective early language learning classes. An enriched writing support environment, collaborative learning, publication of works, peer evaluation, and sharing can boost the quality and quantity of students' works, and enhance students' writing motivation. This project observed and confirmed the support needed by elementary school students engaged in English collaborative writing in the classroom, created the "Ya-Ya Poetry Graffiti Land" online collaborative English writing platform, and performed experimental classroom instruction. The project's most important discoveries included: (1) The level of technological assistance

does not translate into students' mental effort when writing. (2) The writing platform's support during the students' collaborative writing stage is more significant than its assistance during the editing stage. (3) The writing platform facilitates students' peer evaluations, preservation, and display of their works. (4) Guidance from teachers can influence collaborative writing performance. Apart from establishing an expandable EFL writing platform encompassing the sharing of teaching materials and collaborative writing, the project also developed integrated reading/writing teaching materials and teaching strategies for early EFL. The results of this project possess important reference value for those engaged in the planning of early EFL classes and development of digital industry platform tools.

Individualized Context Aware Ubiquitous Learning Environment Research and Experiment: Scholars of education feel that students must participate in learning activities employing sufficiently real scenarios to achieve optimal learning performance. Because of this, learning activities must take place in real environments if the students are to truly understand the subject of instruction. The "Individualized Context Aware Ubiquitous Learning Environment Research and Experiment" concept proposed by the research team in this project included the following aspects: (1) The establishment and verification of a context aware ubiquitous learning guidance strategy library; (2) establishment and verification of individualized context aware ubiquitous learning mechanisms; (3) establishment and verification of an intelligent ubiquitous learning assistance system; and (4) research on ubiquitous learning process perceptions and analytical mechanisms. The project established a context aware ubiquitous learning environment, and applied the environment to an elementary school butterfly ecology teaching activity. The learning system employed sensing technology to guide students to correct observation points (such as a certain ecological area) and explain their learning mission (such as to observe butterfly species and ecology). This system can resolve problems associated with teachers' one-to-many guidance in scenario learning activities, such as students' inattentiveness and lack of individual guidance and immediate feedback.

Deployment and Use of an Online Student Question-Authoring System, and Analysis of Effectiveness: This project seeks to establish a learning environment remedying the shortcomings of existing e-learning environments by providing one question authoring and solution per link, and fostering higher-level thinking skills such as self-adjusted learning, metacognition, and knowledge integration. The learning system developed in this project is termed the "Question-Authoring and Reasoning Knowledge System" (QuARKS), and employs the two main design and symbols of "scaffolding assistance" and customize station. The system can support student question-authoring designs used by instructors at different educational levels in large classroom instruction. By promoting the use of these question-authoring systems and conducting an empirical study, the project made significant contributions in terms of academic originality, socioeconomic effectiveness, and system design innovation. This project was selected by the Taiwan e-Learning and Digital Archives Program's research excellence center as one of Taiwan's most distinctive information education projects, and papers resulting from the project have won accolades from the Asia-Pacific Society for Computers in Education.

(4) Applied science education

ROC-US multinational study of students' use of knowledge management in science, technology, engineering, and mathematics (STEM) learning: This project focused on the learning practice and cooperation of higher-level vocational school students, investigated the use of four knowledge management methods in STEM learning, and ultimately established an online knowledge management learning hardware and software environment. Thanks to the highly diversified learning methods and content of the system design, which contrast sharply with traditional teaching models, students increased their knowledge reuse, transfer, application, and integration. The system encourages students to flexibly apply knowledge to interdisciplinary subjects and new areas of technology, while increasing students' interest in learning STEM knowledge, boosting their problem-solving ability, and training individuals possessing analytical and integrative skills.

A Professional Technical Manpower Training Model for the Hospitality Industry－A Senior Professional Technical Hospitality Industry Manpower Training Model: This project developed a professional skills framework for senior managers in the hotel industry. This framework consists of 13 areas encompassing general professional skills, namely the items of analysis, strategic management, implementation, problem-solving, crisis handling, culture, interpersonal skills, communication, leadership, self-management, attitude, creativity, and foreign language skills, as well as 58 skill indicators derived from the 13 areas; and also includes technical professional skill items consisting of on-

**Each student holds a mobile wireless RFID sensing device in the ubiquitous butterfly ecology learning environment, and this device interacts with a learning system on the computer server via a wireless network. The learning system can determine students' locations, and can guide them as they complete their learning missions. Furthermore, the system can provide individualized feedback and supplementary information via analysis of students' ecological observation records.**

**Photo / text: Prof. Huang Kuo-chen, Department of E-learning Technology, National Tainan University**

**Students' works from a STEM online project-based learning activity**

**Photo source: Prof. Luo Hsi-che, Graduate Institute Technical and Vocational Education, National Pingtung University of Science and Technology**

site management, human resources, financial management, sales and marketing, and information skills, as well as 49 skill indicators derived from these technical skill areas. It was discovered following analysis that general professional skills are more important than technical professional skills. The hospitality industry management skills framework and questionnaire, analysis of training needs, course design model, and teaching strategies developed in this project will provide the hospitality industry with a systematic training model that may guide future efforts to develop the skills of management personnel.

Establishment of Assessment Indicators for the Organizational Innovation of Schools in the Vocational Education System: This project combined organizational innovation indicators and an organizational innovation climate scale for schools in the vocational education system to provide schools at all levels with basis for the development of organizational innovation. The project found that schools' organizational innovation consists of the seven aspects of leadership innovation, administrative innovation, student assistants and activity innovation, class and instructional innovation, teacher professional development innovation, resource use innovation, and campus development innovation. These aspects encompass 25 indicators and 85 reference guidelines at the vocational college and technology university level and 24 indicators and 73 reference guidelines at the vocational high school level. Factors affecting the innovation climate in schools include the five major dimensions of on-the-job autonomy, organizational learning, resource support and leadership, innovative organizational culture, and group solidarity. The findings of this project can be applied to the assessment of organizational innovation in vocational schools at all levels.

ROC-US multinational study of use of knowledge management by vocational high school students to perform STEM problem-oriented learning: This project investigated the performance, substance, and characteristics of project-based learning and problem-oriented learning applied to STEM education and cooperative learning at the high school and vocational high school level, and constructed a STEM project behavioral model. This project took students participating in STEM project activities at a high school and vocational high school in Pingtung as its subjects; the students worked on "solar car," "cup speaker," and "Sterling engine" research projects in sequence. The project established a STEM learning knowledge web site and STEM activity teaching materials to provide learning scenarios, and the researchers served as online teaching assistants. The project's results revealed that STEM project-based learning and problem-oriented learning had a positive influence on students' learning performance, learning attitude, and collaborative learning. In addition, it was found that significant positive correlations exist between such potential variables in the STEM project-based learning model as attitude, perception, behavioral intention, and behavioral performance, and overall performance in the project-based learning model is influenced by learning attitude and process.

(5) Medical education

Integrated Clinical e-Learning System – Clinical e-Learning System: Use of Evidence-Based Medicine to Establish a Pediatric Clinical e-Learning System: The core of medical education is instilling clinical decision-making ability. The design of this project sought to meet the needs of e-learning for general medicine core pre-graduation classes, and relied on interactive learning and image processing, and use of a computer to record users' implementation steps, to achieve the provision of teaching materials with unified standards, improve the effectiveness of clinical learning, instill the habit of active learning, reduce instructors' burden, and assess students' clinical decision-making processes. As a result, since students' pre-graduation core medical classes have depth and mutual linkage, overall planning should be performed when the students enter clinical practice. The project's research methods and steps included adoption of the spirit of problem-oriented and evidence-based medicine, production of an actual e-learning case to serve as a model, and investigation of how professional knowledge is integrated in various cases in an effort to develop an appropriate operating model. The researchers hope that this project will lead to the establishment of an integrated clinical teaching system for medical students, physicians, and nursing students; other cases will be designed based on learners' levels, and will be replicated in other departments at the hospital.

Spiritual Growth Education for Medical Team Personnel Undergoing Hardship, Burnout, Transformation, and Renewal—Establishing Continuing Education Classes to Prevent Physician Burnout and Provide Spiritual Well-being: This project administered a questionnaire survey to 417 physicians at Mackay Memorial Hospital, and conducted in-depth interviews with 12 of the physicians. The project's findings indicated that the better a physician's well-being, the more he or she will be engaged in his or her work; conversely, the more demoralized a physician, the more he or she will feel a sense of occupational fatigue. Population analysis revealed that, with regard to position and seniority, general/resident physicians as a whole have a poor sense of well-being and relatively severe occupational fatigue. It was also discovered from qualitative interviews that physicians who have strong religious belief, a sense of mission, or interest in their work do not readily succumb to burnout. This indicates that the relationship between the burnout of physicians and their workload and on-the-job stress is not absolute. The researchers therefore concluded that the establishment of spiritual growth classes for physicians might prevent burnout by increasing the physicians' self-exploration, work engagement and interest, and sense of mission.

Establishment of a Health Literacy Model for Adults in Ethnic Chinese Areas and Assessment: Performance assessment for e-health technology intervention involving establishment of a cross-cultural scale, verification of relationships, capacity enhancement, and doctor-patient communication theory: This project analyzed the effect of the various elements of e-health technology intervention on adult health literacy, perceived state of health, doctor-patient communication, health behavior, and physiological indicators. The project constituted the first experimental study in Taiwan to examine health literacy intervention; the researchers conducted an intervention employing Internet technology and designed teaching materials consistent with degree of health literacy. During the three-month intervention, when the researchers began tracking after one month, they discovered that the intervention measures had significantly enhanced patients' disease care ability. The health literacy metabolic syndrome care handbook developed in the project was able to significantly improve the care ability of metabolic syndrome patients, improve doctor-patient communication, and facilitate the design of future teaching materials by medical care personnel. The results of this project can serve as a reference for other health education projects focusing on patients' health literacy.

(6) Participation in international educational assessment programs

During the year, the NSC and the Ministry of Education continued to jointly participate in the international Trends in Mathematics and Science Study (TIMSS-2012), Progress in International Reading Literacy Study (PIRLS 2011), and Program for International Student Assessment (PISA 2012). The first two of these programs will conduct surveys of the mathematics and reading skills of the same samples of fourth-grade elementary school students in 2011, and PISA will add a computerized assessment sample to its assessment of students' mathematics and problem-solving skills in 2012.

(7) Indigenous Science Education Project

This project, which began in 2009, seeks to develop teaching materials incorporating elements of indigenous life and culture, and reflecting students' academic level and background knowledge, while also training science educators with local backgrounds to bring science and technology into indigenous life. The project hopes to teach science, information, and technology to indigenous students employing their familiar traditional cultures and ideas, and making science a means of indigenous self-improvement. This project includes:

Selection of research projects: The seven approved four-year integrated research projects begin implementation on July 1, 2009; there are 17 participating universities and colleges and 16 participating indigenous elementary and middle schools, which are located in Taipei, Yilan, Hsinchu, Pingtung, and Hualien. There are 86 participating teachers and approximately 663 students belonging to Taiya, Saisiat, Paiwan, and Amis indigenous groups. Following the completion of 106 teaching modules, trial instruction was implemented at cooperating schools. The 22 promotion activities held this year attracted a total of 2,435 participants. The project has resulted in 50 domestic and foreign academic papers; for example, the paper "Improving the Science and Mathematics Reading Ability and Learning Motivation of Indigenous Students" investigated the difficulty reading science texts experienced by students from the Taiya tribe due to their language background, and used its findings to develop appropriate science teaching modules and teaching strategies.

The project "Instruction and Assessment Model for Indigenous Public Elementary and Middle School Health and Medical Education Classes – Design of an Indigenous Public Elementary and Middle School 'Medicine and Culture' Education Class" has attempted to design indigenous elementary and middle school health and medicine education classes that embody both traditional indigenous culture and the spirit of medicine. Qualitative interviews with Taiya elders were employed to investigate the Taiya outlook on life and death; the collected information will be used in the technical book "The Taiya View of Life and Death."

Training for popular science education seed instructors with local roots: Workshops held in Kaohsiung, Pingtung, Taitung, and Hualien counties attracted 871 participants; 278 of the participating teachers teach at indigenous schools (schools in which indigenous students account for at least 25% of the student body), and 108 of these teachers were of indigenous ancestry. The teachers participating in the workshops expressed a level of satisfaction in excess of 90%.

Encouraging interchange between urban and rural students: The project conducted an urban-rural interchange event involving Lixing Elementary School in Renai Township, Nantou County; 78 students from this school visited Zhongzheng Elementary School in Taichung, and also made trips to the National Palace Museum and National Taiwan Science Education Center. This activity broadened the perspectives and enhanced the learning motivation of indigenous schoolchildren living in a remote area.

Indigenous science education teaching plan selection: This project selected outstanding teaching plans with clear, substantive content that can be immediately used by classroom teachers; these teaching plans will used to develop teaching materials appropriate for specific indigenous groups that may be used by the Ministry of Education in the future.

Establishment of an indigenous science education web site: The content of this web site includes introductions and links to existing online indigenous resources, a database concerning project team members, an online real-time message board, a general discussion area, an online photo album, and information on activities. This web site has facilitated communication between the indigenous science education project office and the various subprojects, and can also publicize the content of the project and relevant information among the browsing public.

Indigenous Science Day: In order to blend science and indigenous culture and implant science and technology in indigenous life, the NSC conducted the "Indigenous Science Day" activities in an indigenous village: The event held in Kazhageilan Village in Majia Township, Pingtung County and at Jiayi Elementary School included popular science activities connected with Paiwan tribal culture, including Tears of the Sun (glass beads: forms and characteristics of matter), Vegetable Dye Style (transformations of matter in everyday life), Paiwan Heroes (mathematical concept of equal division, velocity), Tribal Pledge (use of money), Family Emblems (recognition of geometric shapes), Beauty of Beading (permutations), the King's Token (regularities and symmetry), and Paiwan Starry Night (Earth and space). These activities let participants personally experience a blend of traditional tribal culture and science.

**Numbers of Science Education Specific-topic Research Projects and Funding, 2010** **Units: NT$1 m**

| Item | Applications | | Approved | | Implemented | |
|---|---|---|---|---|---|---|
| | Projects | Funding | Projects | Funding | Projects | Funding |
| Mathematics education | 76 | 84.31 | 43 | 29.01 | 63 | 48.88 |
| Science education | 130 | 260.67 | 68 | 60.53 | 156 | 146.41 |
| Information education | 207 | 244.97 | 102 | 69.82 | 173 | 138.79 |
| Applied science education | 411 | 439.28 | 177 | 110.54 | 308 | 197.52 |
| Popular science education | 432 | 643.81 | 102 | 226.39 | 136 | 255.24 |
| National science and technology programs[1] | 86 | 194.46 | 43 | 110.39 | 43 | 110.39 |
| Indigenous science education project | 17 | 34.80 | 17 | 24.95 | 17 | 24.95 |
| Science education for diversified groups | 103 | 100.68 | 49 | 29.95 | 55 | 35.86 |
| Science education and mass communications | 80 | 126.60 | 34 | 24.17 | 79 | 54.29 |
| Other | 8 | 12.38 | 1 | 0.40 | 3 | 1.41 |
| **Total** | 1,550 | 2,141.96 | 636 | 686.15 | 1,033 | 1,013.74 |

[1] Includes digital archives and e-learning, energy saving and carbon reduction, and nanometer

Science Education Specific-topic Research Project Manpower, 2006-2010 Units: person-times

| Item | | 2006 | 2007 | 2008 | 2009 | 2010[1] |
|---|---|---|---|---|---|---|
| Research personnel | Professors | 643 | 924 | 614 | 682 | 803 |
| | Associate professors | 818 | 929 | 530 | 616 | 684 |
| | Assistant professors | 523 | 633 | 403 | 458 | 518 |
| | Lecturers | 158 | 165 | 80 | 64 | 77 |
| | Other | 62 | 82 | 72 | 101 | 142 |
| Subtotal | | 2,204 | 2,733 | 1,699 | 1,921 | 2,224 |
| Research assistants | Full-time assistants | 195 | 209 | 248 | 272 | 289 |
| | Part-time assistants | 366 | 344 | 344 | 301 | 283 |
| | Graduate students | 2,013 | 1,995 | 2,281 | 2,383 | 2,606 |
| Subtotal | | 2,574 | 2,548 | 2,873 | 2,956 | 3,178 |
| **Total** | | 4,778 | 5,281 | 4,572 | 4,877 | 5,402 |

[1] 2010 data is to January 29, 2011

Numbers and Percentage of One-year and Multi-year Science Education Specific-topic Research Projects, 2006-2010

| Year | Total projects | One-year projects (%) | Multi-year projects (%) |
|---|---|---|---|
| 2006 | 661 | 270（40.85） | 391（59.15） |
| 2007 | 644 | 240（37.27） | 404（62.73） |
| 2008 | 778 | 240（30.85） | 538（69.15） |
| 2009 | 853 | 256（30.01） | 597（69.99） |
| 2010 | 1,033 | 413（39.98） | 620（60.02） |

## B. Industry-Academic Collaborative Research Projects

For many years the NSC has actively promoted industry-academic collaborative research projects in order to harness the abundant R&D resources of the academic sector and train technological personnel with practical experience. The mutually-beneficial model employed in industry-academic collaborative research projects has supported and boosted the R&D capabilities of domestic companies, and the forward-looking technologies developed in these projects have made a major contribution to competitiveness of domestic industry.

In light of changes in the technological environment, the NSC revised the *Operating Guidelines for the Funding of Industry-Academic Collaborative Research Projects* in 2008 in order to promote more forward-looking industry-academic collaboration assistance strategies and establish stronger up- and downstream linkage involving the results of industrial-academic collaboration. This revision unified the NSC's major and minor collaborative projects and digital content collaborative projects, established new pioneering, developmental, and applied industrial-academic collaborative project types, provided more flexible regulations and accompanying mechanisms, and established a more open industry-academic collaboration platform. After reviewing the results of implementation, the NSC again revised certain articles of the *Operating Guidelines* in 2010; the following are the key points of the revisions:

(1) The preliminary technology transfer licensing amount and technology transfer agreement are listed as review focal points.

(2) The revision explicitly states that, in the case of pioneering and developmental industrial-academic collaborative project types, collaborating firms may send personnel to participate in planning or provide equipment for project use as part of their funding contribution, and the amounts shall be calculated as part of manpower funding or equipment funding; in addition, in the case of developmental projects, only when collaborating firms choose to provide preliminary technology transfer licensing fees may they apply to include sending personnel to participate in project implementation as part of their manpower funding contribution.

(3) When two or more collaborating firms participate in an integrated project, each firm's funding ratio shall be calculated on the basis of the subprojects in which it participates.

Industry-academic Collaborative Research Project Implementation Performance, 2006-2010

| Item | 95年 | 96年 | 97年[1] | 98年[2] | 99年 |
|---|---|---|---|---|---|
| Number of projects | 1,046 | 1,084 | 588 | 1,103 | 944 |
| Funding (NT$1 m) | 532.14 | 495.46 | 431.48 | 1,096.00 | 716.93 |
| Number of participating firms | 1,048 | 1,090 | 584 | 1,130 | 954 |
| Corporate contribution (NT$1 m) | 251.11 | 226.45 | 174.35 | 324.77 | 301.63 |
| Manpower training (M.S. & Ph.D. students) | 1,811 | 1,848 | 1,248 | 2,718 | 2,057 |
| Approved patents | 44 | 30 | 21 | 46 | 50 |

[1] The 2008 revision of the *Operating Guidelines for the Funding of Industry-Academic Collaborative Research Projects* changed the application times for applied industry-academic projects from twice annually to once annually, which reduced the number of applications.

[2] The restoration of twice-annual applications in 2009 led to an increase in the number of projects.

## C. National-Level Science and Technology Programs

*In accordance with the National Science and Technology Program Promotion Guidelines*, to respond to the country's leading socioeconomic and civil issues, the government has assigned first priority to full-scale promotion of national science and technology programs aimed of the maximizing the return on R&D results; this promotion will take the form of government guidance of inputs and long-term support, and will involve interagency integration of Taiwan's up-, mid-, and downstream sectors as well as the resources of industry, government, academia, and the research community. The promulgation of the *National Science and Technology Program Promotion Guidelines* in 1998, and its revision in 2003, has made the formulation and implementation of national science and technology programs much more concrete and regular. Three initial national programs on disaster mitigation, telecommunications, and agricultural biotechnology were followed by a program on biotech pharmaceuticals in 2000, and five programs respectively concerning digital archives, genomic medicine, chip systems, nanotechnology, and e-learning in 2002, resulting in a total of nine national science and technology programs. Of these, the National Science and Technology Program for Hazards Mitigation was concluded at the end of 2006. The national science and technology programs received total annual funding of NT$11.1 billion, NT$12.8 billion, NT$11.8 billion, NT$12.7 billion, NT$11.3 billion, NT$11.0 billion, and NT$13.9 billion respectively during the years from 2003 to 2009.

### 1. Networked Communication Program

Implementation of the Networked Communication Program began in January 2009, and the program will have a period of five years. This program focuses on information and communications technologies (ICT) with telecommunications applications, and encompasses communications, information, and integrated applications service technologies. In addition, the program is also addressing the formulation of a legal and regulatory environment encouraging the development of these technologies. The program seeks to both conform to the global industry trend toward integration and convergence and also the needs of domestic industrial development. The program's content includes the four major items of access technology, communications software and platform technologies, applications service technologies, and legal / regulatory environment. In view of foreign technology development standards and the current state of domestic industry, the program has conducted a comprehensive review of ICT and the industry and drafted a forward-looking communications technology strategy intended to boost the development of the domestic information & communications industries and achieve the program's five major missions: Strengthening coordination and division of labor in connection with R&D efforts at relevant government agencies, boosting R&D efficiency, training more ICT manpower, researching and developing key industrial technologies, and strengthening the productivity and competitiveness of information & communications service and manufacturing industries.

The following major results were achieved during the year:

(1) Major innovative inventions:

a. Development of a world-leading broadband mobile, high-power CMOS power amplifier: CMOS power amplifiers (PAs) are the final piece in the CMOS SoC single chip integration puzzle. The Industrial Technology Research Institute (ITRI) joined forces with the Taiwan Semiconductor Manufacturing Co. (TSMC) and United Microelectronics Corp. (UMC) to perform technology development and create a patent portfolio, establishing the leading status of ITRI's technology. Inventions including a new on-chip transformer, high-efficiency bias circuit, and linear architecture resulted in 15 patents in four projects. The program's forward-looking results attracted TSMC and UMC as partners, leading to the establishment of Taiwan's first on-chip/on-package CMOS signal measurement system. The measurement of a 0.18 TSMC CMOS power transistor in December 2010 showed that the transistor could achieve a power of 1 W at 2.6 GHz, and had an efficiency of 28%. A collaborative effort with the Department of Electrical Machinery at National Taiwan University will seek to jointly develop a new-type digital predistortion algorithm, which is expected to sharply raise circuit efficiency and increase technology competitiveness. The development of this technology will enable domestic CMOS fabs and IC design companies to enter the foreign-dominated front-end RF market.

b. Wireless broadband base station software technology: The Institute for Information Industry (III) is vigorously engaging in wireless broadband base station software technology R&D, and has developed Taiwan's first domestically-made prototype WiMAX/3G base station system; the technology emerging from this project can be applied to base station, user terminal, and chip development. Furthermore, III has actively participated in the drafting of IEEE 802.16/3GPP international standards and has assembled a portfolio of key patents, which will help Taiwanese firms to seize market opportunities and establish themselves in highly-profitable markets.

c. Establishment of a world-leading HSR broadband wireless environment and technology: ITRI assembled an American / Japanese / Taiwanese team that includes ITRI, the Nippon Telegraph and Telephone Corporation Broadband Platform (NTT-BP), Japan's Access Network Service Systems Laboratories (AS LAB), and the US firms Corning and VMAX in order to perform the world's first high speed railway (HSR) WiMAX (worldwide interoperability for microwave access) broadband operation experiment, and develop an HSR broadband wireless environment and technology. This project completed establishment of a WiMAX / ROF network system platform that encompasses the monitoring station in the Hsinchu Science Park, the Hsinchu HSR station, and the Litoushan and Hukou tunnels. An experiment testing WiMAX base station handoff performance and high-speed data transmission while trains were traveling at 300 km/h in open areas revealed that hand over latency was 104 msec, and the average and maximum transmission rates were 6 Mbps and 11.5Mbps respectively. ITRI's collaboration with Corning resulted in the development of WiMAX+RoF (radio over fiber) distributed antenna technology. The project also verified that the maximum data transmission rate at a speed of 300 km / h was 11.5 Mbps, which will allow problem of communications within HSR tunnels to be solved.

d. Sensing and energy information and communications: This project is actively developing green energy information and communications and safety sensing technologies. The project has completed a common sensing information service platform and bridge application platform, developed a bridge monitoring and warning system, helped the government of Hsinchu County to develop user-end bridge communications

technology, and employed integrated communications monitoring and information management to help firms promote advanced back-end meter-reading technology.

(2) Active participation in the preliminary drafting of 4G mobile communications international standards, drafting of WiMAX international standards, and drafting of vehicle-carried information & communications network international standards:

a. Taiwan participated in the international standards conferences and standards drafting work in conjunction with the Third Generation Partnership Project (3GPP), IEEE 802.16m, IEEE 802.11p and the Open Geospatial Consortium (OGC) on 48 occasions (200 person-times); the transformation of R&D results into essential IPR through these efforts will provide IPR support to the telecommunications industry, enabling the industry to upgrade itself and enhance its value.

b. A total of 333 technological proposals were made by the project, of which 153 were accepted, and 13 of the latter proposals will provide opportunities to acquire essential IPR; firms jointly submitted 56 of the proposals. Apart from securing more votes at various standards conferences, this effort will ensure that Taiwan's technology R&D standards earn respect.

c. By assembling and cultivating a team of more than 62 individuals dedicated to participating in study and drafting of international standards, the NSC boosted the country's R&D capabilities and helped Taiwan secure a leading role in international technology development efforts.

(3) Effectively boosting the qualifications of communications manpower via NSC academic specific-topic research projects and the MOE's communications manpower improvement program:

a. Mid-term Telecommunications Technology R&D Framework Plan: This project resulted in the publication of 191 journal articles and the issuance of 300 conference papers, and provided training to 25 Ph.D. graduates and 280 M.S. graduates, boosting the industry's human resources base.

b. Information security curriculum: The program employed on-site internships during summer and winter vacations to enhance learning results; a total of 873 students taking the classes obtained ISO 27001 information security licenses.

c. The Promotion Center for the Telematics Consortium has published the English-language teaching material *Telematics* Communication Technologies and Vehicular Networks：*Wireless Architectures and Applications* for international use; the results of the program have led to the production of several localized and international textbooks and experimental teaching materials.

d. The RF module series among the Wireless Communications Instructional Promotion Alliance Center's "RF and Antenna Module" teaching materials is composed of 16 class modules and employs the "LegoRF" concept; paralleling the use of Lego blocks, each student is able to assembly RF circuits and operating instruments while learning RF theory and the implications and functions of electromagnetic modeling. Apart from bridging the gap between school and the workplace, this teaching material series also obtained the award of excellence in the 2010 Superior Teaching Materials Awards.

(4) The MOTC's "Communications Resource Planning and Research" project:

a. Mid-／long-term optimized electromagnetic spectrum planning for Taiwan: This project proposed a draft spectrum allocation map for Taiwan accommodating mobile broadband communications uses to 2020. The project surveyed various mechanisms for enhancing frequency use efficiency, including secondary trading, recycling, and frequency sharing mechanisms, and proposed a frequency use plan that can be implemented after the licensing of the 3G mobile Internet (time division duplexing – TDD) band and personal handy-phone systems (PHS).

b. Overall planning for the Telecommunications Numbering Plan: A numbering project for next generation network (NGN) services completed research on development trends and numbering strategies for fixed network mobile convergence (FMC) and voice over internet protocol (VoIP). In addition, the project recommended that an area code consolidation planning proposal be drafted in parallel with the Long-Term National Land Development Blueprint approved at the "National Land Spatial Development Strategy Planning Conference" and reflecting a conceptual framework of three living circles located in northern, central, and southern Taiwan respectively. The specific number conservation methods devised in the project include number recycling, collection of number use fees, and number application handling mechanisms.

c. New-generation Internet protocol interoperability and certification: More than 95% of city and county network centers and elementary and middle schools in Taiwan have adopted Internet Protocol version 6 (IPv6) networks. Thus far 72 gold IPv6 Ready Logo marks and 79 silver logo marks have been issued, giving Taiwan a rank of third worldwide in both categories. The 35 gold logo marks issued during 2010 accounted for one-fourth of the new marks issued worldwide. IPv6 network traffic increased by a factor of 46.5 for the year, the number of IPv6 WWW web sites increased by a factor of 12, and the number of IPv6 user-end domain name service (DNS) queries grew by a factor of nine.

(5) DOH Bureau of Health Promotion's "Epidemiological Study of the Health Effects of Electromagnetic Fields":

a. The project "Effect of RF Electromagnetic Radiation on Children's Health" discovered that cell phone usage among students from the fifth year of elementary school to the third year of junior high school was 63.2%, and the older children had the highest cell phone usage, but there were no significant differences in usage due to gender, region, or public/private school. The project also found that cell phone-using children had significantly higher odds of suffering unfavorable health effects such as headache/dizziness, skin irritation, or seeking care from a doctor of Chinese medicine. However, because this study failed to adequately account for confounding factors, it proved impossible to reach further conclusions. The project further discovered that the parents of children in Taiwan are very aware of the danger of electromagnetic radiation from cell phones and base stations, and feel that risk should be avoided as much as possible; the project concluded, however, that lack of full information may be the cause of anxiety among cell phone users, and proposed appropriate recommendations.

b. The project "Establishment of a Quantitative Model of Human Exposure to Electromagnetic Radiation" completed 120 person-day measurements of members of five groups: the general public in northern, central, and southern Taiwan, seniors, children, pregnant women, and employees working in areas exposed to high-frequency electromagnetic radiation.

The results of this survey were consistently below the legal limit and the values recommended by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). It was also found that sitting exposure is consistently less than standing exposure, and nighttime exposure was also less than daytime exposure. Peak exposure to electromagnetic radiation occurs around noon. Although some working and living environments near base stations have somewhat elevated environmental electromagnetic radiation exposure levels, these are still less than the legal limit.

**Number of Networked Communication Program Projects and Funding, 2010**

| Agency | Projects | Funding (NT$1 M) |
|---|---|---|
| MOEA | 10 | 1,035.110 |
| Industrial Development Bureau, MOEA | 3 | 315.000 |
| Bureau of Standards, Metrology and Inspection, MOEA | 3 | 36.000 |
| NSC | 84[1] | 200.000 |
| MOE | 1 | 179.716 |
| MOTC | 3 | 32.050 |
| Bureau of Health Promotion, DOH | 2 | 5.746 |

[1] Approved projects in 2010 included 66 group projects, six individual projects, 11 deployment projects, and one bridging project.

**Results of Networked Communication Program, 2010**

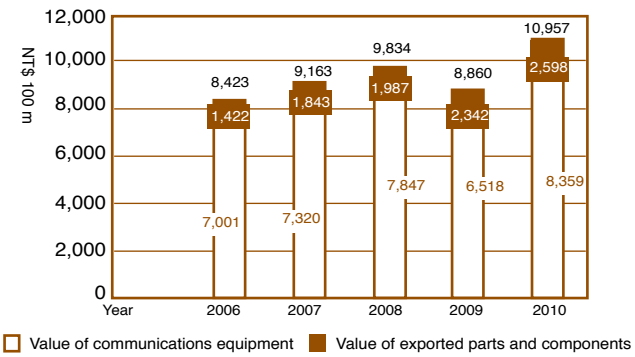
| Item | Quantity |
|---|---|
| Academic papers | 810 |
| Training for Ph.D. and M.S. students (persons) | 351 |
| Patents received | 109 |
| Technology transfer (cases) | 75 |
| Technology transfer contract value (NT$1 m) | 273.643 |
| Corporate investment promoted by program (NT$1 m) | 27,249.817 |

**Networked Communication Program research manpower, 2010**

| Type | Person-years |
|---|---|
| Researchers[1] (and above) | 520.52 |
| Associate researchers[2] | 482.40 |
| Assistant researchers[3] | 731.55 |
| Full-time assistants | 66.28 |

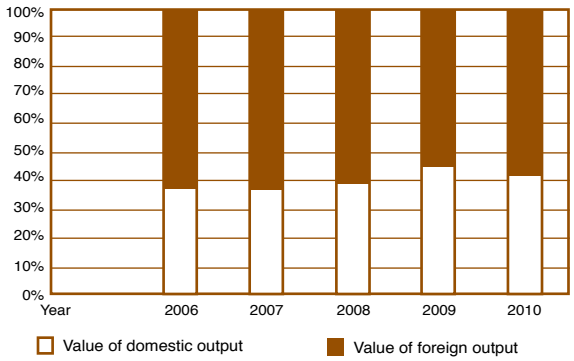
[1] Includes professors ; [2] Includes associate professors and assistant professors ;
[3] Includes M.S. and Ph.D. students

**Value of communications equipment and exported parts and components, 2006-2010**




Source: Industrial Economics & Knowledge Center, Industrial Technology Research Institute

**Value of domestic and foreign communications equipment and exported parts and components, 2006-2010**



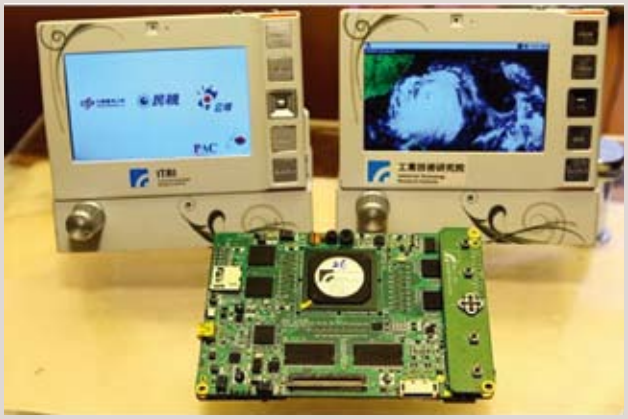

Source: Industrial Economics & Knowledge Center, Industrial Technology Research Institute

### 2. National Science and Technology Program for Systems-on-Chip

The second phase (2006-2010) of the National Science and Technology Program for Systems-on-Chip has the theme of "Versatile Giga-Scale Integration for Better Life." The program's strategy is to promote the upgrading of the semiconductor industry, and thereby realize the vision of a superior quality of life. The program received total funding of NT$1.99 billion in 2010, of which NT$1.95 billion was implemented, for an implementation rate of 98.25%, which was an increase of 1.25% compared with 2009.

The program's three main long-term goals are to develop innovative products, integrate forward-looking technologies, and create a global human resources environment.

The innovative product-oriented systems integration subprogram emphasizes the use of diversified network integration technologies to achieve integration of heterogeneous networks and upper-level applications, and thereby realize seamless applications, IP mobility, and ubiquitous networking. In the area of e-life and the digital home, projects are developing heterogeneous network linking and multimedia product technology enabling enriched entertainment and educational



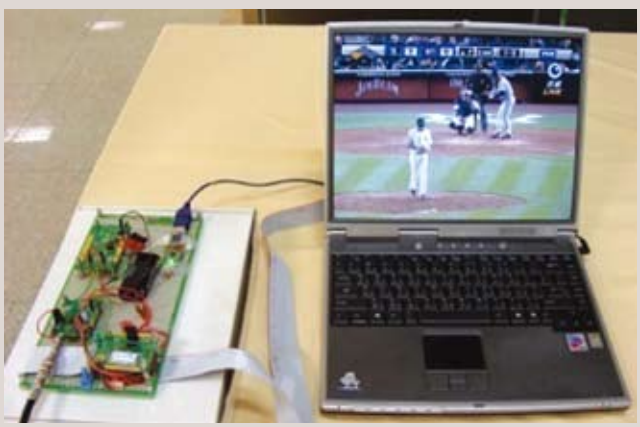
**ITRI's independently developed key core chip technology and intellectual property were employed to develop the world's first WiMAX-Android PID handheld mobile Internet device.**

**Source: ITRI SoC Technology Center**

content. In the area of health monitoring and life care, projects are developing health monitoring and residential care systems, and are linking these systems via networks to create new e-health and e-life applications.

In the area of forward-looking technology-oriented chip integration, the program has successfully developed the world's first WiMAX-Android PID handheld mobile Internet device. ITRI's independently developed key core chip technology and intellectual property were employed to enable video streaming and Android applications on a WiMAX-Android PID with a PAC Duo core employing WiMAX wireless access (MIMO WiMAX Solution, which includes MAC, PHY, ADC/DAC, and RF). This device will have a broad range of applications, including palmtop SNG, multimedia entertainment, real-time disaster monitoring, on-site real-time services, and online video phones.

The ITRI SoC Technology Center has completed development of one of the world's most advanced DVB-H RF tuner ICs; this low power consumption, low-voltage tuner IC can be applied in the next generation of handheld mobile digital video players. The 1.2V TSMC 0.13um CMOS process was used to produce this IC, which has a maximum power consumption of only 114 mW in continuous receiving mode, a maximum power consumption of only 11.4 mW in 10% time slicing mode, and a chip area of only 7.2 mm2. The IC further overcomes low-voltage, low-current, and high-linearity requirements with architecture and circuit design breakthroughs. These R&D results were successfully transferred to the Taiwanese company Mavcom, enabling the firm to greatly advance its cell phone TV chip and system solution capabilities. Working on the basis of existing patents, the SoC Technology Center also issued the new "low-noise amplifier able to receive double-end and single-end input" patent and papers; system manufacturers may be able to use this amplifier, which can be employed in both single-end and double-end systems, as an optimal solution in certain products.



**The SoC Technology Center successfully developed one of the world's most advanced low-power consumption, low-voltage DVB-H RF tuner ICs for use in mobile handheld digital video devices.**

**Source: SoC Technology Center, Industrial Technology Research Institute (ITRI)**

Short-term workshop courses sponsored via an alliance with the Ministry of Education have helped instructors at different schools to continue to plan and develop instructional materials for forward-looking and interdisciplinary courses. Six courses and three modules were added in 2010, for a cumulative total of 73 courses. The SoC alliance instructional material database currently has a total of 710 user registrations, and instructors have downloaded instructional materials a cumulative total of 4,793 person-times. This program has also held international competitions and international activities seeking to investigate relevant technologies and topics in order to let domestic SoC instructors and students to obtain the newest technologies and information from overseas, which has lent a significant impetus to students' and instructors' international perspectives. The 102 seminars held this year attracted a total of 9,072 participants, and three national competitions attracted 2,507 contestants.

The program established the world's first MEMS sensor and SoC heterogeneous integrated design/production/packaging/testing service platform, promoted the SMILE Café alliance, and provided MS MEMS α-trial service. IC design firms have performed trials of heterogeneous integrated design processes and the integrated wafer production and testing service platform developed in the program, and the program has assisted CMOS and MEMS specialists to jointly enter the mixed signal/MEMS stage. Fourteen domestic IC design firms are currently participating in a sensor SoC pilot production project, which is enabling their personnel to experience the entire sensor SoC integrated design and manufacturing process, and helping these CMOS design and manufacturing firms to jointly enter the mixed signal / MEMS stage. These firms hope that the program will help them develop the world's first sensor IP and IC + sensor integrated design processes, and eventually help the semiconductor industry to achieve a long-term competitive advantage in the field of innovative integrated applications (live smarter / live better).

The program has further implemented three projects promoting horizontal integration and meeting short-term technology needs. The first project, which focused on RF and mixed signal circuit design, drafted system architectures and standards, encouraged advanced RF / MSD circuit module design, and established an RF / MSD education improvement alliance. The second project, which concerned embedded software, developed an embedded software applications platform and design platform, and promoted the establishment of an embedded software education improvement alliance. The third project, which addressed heterogeneous integration technology (including SiP / MEMS / sensor integration), promoted biomedical chip system development, system packaging, and MEMS/sensor element design and integration; this project

has also provided resources for the training of heterogeneous integration manpower.

In 2010, the program office held numerous seminars and assessment conferences conducted one year prior to projects' conclusions. These events allowed SoC experts to get together, share their insights, and boost their knowledge and skills. The program office also helped sponsor various international symposia, such as the IEEE International Workshop on Memory Technology, Design, and Testing (MTDT) and the IEEE International SoC Conference, which indirectly enhanced Taiwan's visibility in the field of ICs and semiconductors. Thanks to the implementation of this program, the number of papers issued by authors from Taiwan at the prestigious IEEE International Solid-State Circuits Conference (ISSCC) rose to 18 in 2009, giving Taiwan an international rank of third and putting it behind only the US and Japan. While the proposal share of papers by authors from Taiwan fell slightly in 2010 and 2011, the fact that many of these papers related major breakthroughs in various technological areas indicated Taiwan's R&D prowess in the intensely competitive international semiconductor industry. Furthermore, the number of papers issued by participants from Taiwan at the Design Automation Conference/International Conference on Computer Aided Design (DAC/ICCAD) grew significantly, and the number of academic papers issued by Taiwanese participants at the International Test Conference and VLSI Test Symposium (VTS) also grew steadily, indicating that Taiwan's academic R&D standards are rising significantly in relevant fields.

**Papers from various countries issued at IEEE International Solid-State Circuits Conferences, 2007-2011**

| 2007 | | 2008 | | 2009 | | 2010 | | 2011 | |
|---|---|---|---|---|---|---|---|---|---|
| Country | Papers | Country | Papers | Country | Papers | Country | Papers | Country | Papers |
| USA | 88 | USA | 95 | USA | 72 | USA | 81 | USA | 77 |
| Japan | 27 | Japan | 35 | Japan | 33 | Japan | 32 | Japan | 24 |
| Korea | 25 | Korea | 14 | ROC | 18 | Korea | 19 | Korea | 22 |
| ROC | 20 | ROC | 13 | Korea | 15 | Netherlands | 13 | Netherlands | 17 |
| Germany | 12 | Belgium | 12 | Netherlands | 14 | Italy | 12 | ROC | 14 |
| Italy | 10 | Netherlands | 12 | Belgium | 9 | ROC | 9 | Germany | 11 |
| Netherlands | 10 | Italy | 11 | Italy | 8 | Belgium | 9 | France | 7 |
| Switzerland | 9 | France | 8 | Germany | 7 | Switzerland | 8 | Belgium | 7 |
| Belgium | 7 | Germany | 8 | Switzerland | 4 | Canada | 5 | Britain | 5 |
| Austria | 6 | Canada | 6 | France | 3 | Britain | 4 | Italy | 5 |
| France | 5 | Switzerland | 6 | Austria | 3 | Germany | 4 | Canada | 4 |
| Canada | 3 | Britain | 5 | Sweden | 2 | France | 4 | Switzerland | 3 |
| Finland | 3 | Austria | 3 | Canada | 2 | Hong Kong | 2 | India | 3 |
| Britain | 3 | Hong Kong | 2 | Finland | 2 | Singapore | 2 | China | 3 |

Note: Papers issued at all IEEE International Solid-State Circuits Conferences in a certain year are included in the record for the following year.
Source: Department of Engineering and Applied Sciences, NSC

**Performance indicators and results of the National Science and Technology Program for Systems-on-Chip, 2010 (I)**

| NSoC subproject attributes | Chips developed | International conference papers | International journal papers | Domestic conference papers | Domestic journal papers | Patents | | | | Technology transfers (patents) | | | | | Specialized technologies | Technical reports | Industrial / academic collaboration | | Induced corporate investment | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Domestic | | Foreign | | Cases | | Licensing fees | | | | | | | | |
| | | | | | | Applications | Granted | Applications | Granted | domestic | foreign | Licensing fees (NT$1,000) | Royalties (NT$1,000) | technology transfers | | | Cases | Funding (NT$1,000) | Firms | Investment (NT$1 m) |
| Product innovation | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 5 | 112 |
| Forward-looking technologies | 31 | 552 | 369 | 178 | 71 | 131 | 33 | 95 | 64 | 65 | 1 | 39,823 | 19,913 | 6 | 0 | 622 | 58 | 19,243 | 35 | 611 |
| Manpower & environment | 1,025 | - | - | - | - | 0 | 3 | 0 | 0 | - | - | - | - | - | - | 7 | 6 | 1,741 | 33 | 411,649 |
| Total | 1,056 | 552 | 369 | 178 | 71 | 131 | 36 | 95 | 64 | 65 | 1 | 39,823 | 19,913 | 6 | 0 | 629 | 64 | 20,984 | 73 | 412,372 |

**Performance indicators and results of the National Science and Technology Program for Systems-on-Chip, 2010 (II)**

| NSoC subproject attributes | Academic achievement | Other benefit | Specialized manpower training | | | | | Instructional materials (subjects) | Course attendance (person-times) | Activities | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Manpower training (person-times) | | Formative education | | | | | Competitions | | Seminars | |
| | Research teams established (persons) | Standards drafted (cases) | Short-term | Mid-/long-term | Ph.D. | M.S. | Other | | | Events | Persons | Events | Persons |
| Product innovation | - | - | - | - | - | - | - | - | -- | - | - | - | - |
| Forward-looking technologies | 51 | 3 | - | - | 549 | 1,510 | 5 | 140 | - | 2 | 2,760 | 158 | 10,919 |
| Manpower & environment | 25 | 1 | 4,019 | 277 | 340 | 2,759 | 212 | Education [1]: 6 new courses and 3 modules; teaching materials database added new materials for 16 courses. Training [2]: 5 new courses. | 35,269 | 3 | 2,507 | 102 | 9,072 |
| Total | 76 | 4 | 4,019 | 277 | 889 | 4,269 | 217 | | 35,269 | 5 | 5,267 | 260 | 19,991 |

[1] Refers to education courses ; [2] Refers to training courses

### 3. National Science and Technology Program for Nanoscience and Nanotechnology

The first phase of the National Science and Technology Program for Nanoscience and Nanotechnology (2003-2008) resulted in the establishment of several research teams meeting international standards. The program also encouraged more than one hundred firms to invest in R&D and technology transfer, and has encouraged much greater attention to manpower training.

Apart from building on the results of the first phase, the second phase of the program takes the industrialization of nanotechnology as its main theme, and is focusing on forward-looking nanotechnology research, biomedical / agricultural research, nanometer energy and environmental research, nanometer electronics and optoelectronics technology, nanomaterials, applications of nanotechnology in traditional industries, and development of instruments and equipment. The program is further promoting major strategic projects integrating the efforts of different government agencies, including work in the strategic areas of environmental / safety / health issues, manpower training, nanotechnology standards, and nanometer marks; these projects in these areas are intended to mesh with the overall planning and implementation of the program.

The NSC is responsible for funding academic excellence and core facility establishment and sharing projects. Academic excellence projects focus on the five main directions of basic research in nanoscience, nanomaterials, key nanometer control / functional element fabrication / special instrument technologies, nanometer energy research, and nanometer biotechnology, environmental safety, and health technology. To ensure that the results of nanoscience research can be realized in concrete industrial application, the NSC is actively playing the role of matchmaker between research organizations' technological breakthroughs and industry's innovative application ideas, and is promoting industrial-academic collaborative projects geared to speeding the commercialization of research successes. The following were some of the most notable research results during the year:

Carbon-based raw materials technology is one of the industrial areas where Taiwan currently lacks professional expertise. A research project employed supercritical fluid technology to extract coal tar pitch and petroleum asphalt, remove solid foreign matter from the asphalt, and adjust the asphalt's molecular weight distribution. The project further used this method to produce highly oriented, opthically anisotropic mesophase asphalt materials; these materials can be used in the field of radiation cooling to replace current traditional aluminum and copper metal radiators, and their high thermal conductivity will allow them to be used in a wide range of applications.

Research in advanced semiconductor process measurement technology successfully developed infrared confocal scanning microscopy, which can be used to determine the characteristics of silicon chip materials transmitting infrared radiation and perform through-focus measurements. The project has developed an algorithm to derive the optimally focused image through upper and lower TSVs, allowing the technique to be used to measure through-silicon via (TSV) upper/lower via diameter (via CD $\geqq 10\,\mu$m) and via depth.

In research on broadband vertical incidence reflectometry, researchers applied reflection interference technology at different TSV upper / lower via depths and used a patented high-frequency amplitude modulated measurement algorithm to measure TSV depth and shape. This method is especially

suitable for measuring the diameter and depth of TSVs in high-density, small (≦10 μm) arrays. A project on shadow moire interfermetry measurement technology measured the surface form of a wafer before and after film deposition; surface form can provide information on wafer warpage or bowing, and also allows use of the Stoney formula to derive wafer film stress.

With regard to nanometer mark certification mechanisms, the NSC has established certification standards for seven nanometer products; a total of 366 products made by eight firms have passed nanometer mark certification thus far. Taiwan's nanometer mark is a global innovation, and to date no other country has a similar system. The nanometer mark can help consumers select correct nanometer products, give recognition to makers of superior products, and ensure that the domestic nanotechnology industry develops in a sound manner.

**2010 Nanometer Mark certificate awards ceremony hosted by the Industrial Development Bureau, MOEA**

**Source: Industrial Development Bureau, MOEA**

**Major results of the National Science and Technology Program for Nanoscience and Nanotechnology, 2006-2010**

| Item | | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|
| Papers and IPR | Papers in international journals | 1,314 | 1,693 | 1,717 | 1,380 | 1,344 |
| | Patents | 937 | 1,068 | 947 | 1,278 | 764 |
| | Technology transfer cases | 94 | 154 | 131 | 98 | 108 |
| Manpower training | Ph.D. student training (person-times) | 661 | 893 | 738 | 428 | 754 |
| | M.S. student training (person-times) | 1,070 | 1,394 | 1,281 | 979 | 1,237 |

### 4. National Science Technology Program-Energy

The National Science Technology Program-Energy is the tenth national science and technology program implemented by the NSC; it was established pursuant to resolutions made at conferences of the Executive Yuan Energy Policy and Technology Development Steering Committee, and seeks to focus effort on the 15 energy technology development items formulated at the November 2007 National Industrial Technology Conference. The program was approved by the 23rd Science and Technology Meeting of the Executive Yuan in December 2007.

The first five-year phase of this program (2009-2013) focuses on integrating existing and new projects. Energy-related project resources at the NSC, Bureau of Energy, MOEA, Atomic Energy Council, Ministry of the Interior, Ministry of Transportation and Communications, Council of Agriculture, and Environmental Protection Administration were incorporated into the National Science Technology Program-Energy in 2009. The total budget for the first phase of the program is approximately NT$30.3 billion.

**Objectives of the National Science Technology Program-Energy**

| Actions and measures | Objectives and timetable |
|---|---|
| Enhancing energy autonomy and security | • Renewable energy will account for 12% of installed generating capacity by 2020 (i.e. 6,500 MW)<br>• Installed capacity of nuclear energy will increase to 8.55 GW by 2020 |
| Reduction of greenhouse gas emissions | • Emissions will fall to the 2005 level by 2016-2020<br>• Emissions will fall to the 2000 level by 2025<br>• Emissions will fall to 50% of the 2000 level by 2050 |
| Creating an energy industry | • The green energy industry will achieve an output value of NT$1.16 trillion by 2015 (approximately 6.6% of manufacturing output in that year) |
| Boosting energy use efficiency | • Energy efficiency will rise by 2% annually during the period 2009-2016, which will reduce carbon dioxide emissions by 54.83 Mt/y and which is equivalent to energy conservation of 85,806 GWh/y |
| Improving the energy use structure | • Low-carbon energy will account for at least 55% of all energy use by 2025 |

**Funding implementation, National Science Technology Program-Energy, 2010**

| Item | Competent authority | Statutory budget (NT$1,000) | Amount implemented (NT$1,000) | Implementation rate (%) |
|---|---|---|---|---|
| Energy technology strategies | NSC, Industrial Development Bureau | 314,465 | 166,804 | 53 |
| Energy technologies | NSC; Atomic Energy Council; Bureau of Energy, MOEA; Industrial Technology Department, MOEA; Central Geological Survey; Bureau of Standards, Metrology and Inspection | 2,856,483 | 1,950,097 | 68 |
| Energy conservation / carbon reduction | NSC; COA; Bureau of Energy, MOEA; Institute of Transportation; Industrial Technology Department, MOEA; Architecture and Building Research Institute, MOI; Bureau of Standards, Metrology and Inspection; Industrial Development Bureau | 1,557,248 | 961,031 | 61 |
| Manpower training | NSC, MOE, EPA | 177,881 | 176,902 | 99 |

**Performance indicators and results of the National Science Technology Program-Energy, 2010**

| Item | Target | Attained value |
|---|---|---|
| Papers | 500 | 1,656 |
| Ph.D. & M.S. training | 500 | 2,406 |
| Patents received | 45 | 452 (including pending) |
| Technology transfer (cases) | 200 | 199 |
| Technology transfer Licensing fees (NT$1,000) | 200,000 | 214,039 |
| Induced corporate investment (NT$1,000) | 300,000 | 7,369,330 |


**The "2010 International Forum on Offshore Wind Power Generation Technology" was held at National Taiwan University's Institute of Applied Mechanics on November 24, 2010. Among the domestic and foreign experts and scholars invited to this event were (from left to right) Associate Prof. Yu Cheng-ta of Leader University, Assistant Prof. Kuo Yu-shu of National Cheng Kung University, Prof. Lin Ta-hui of National Cheng Kung University, German Researcher Florian tom Wörden, and German Manager Rainer Riecke.**

**Source: National Science Technology Program-Energy office**

**5. National Science and Technology Program for Biotechnology and Pharmaceuticals**

The third phase of the National Science and Technology Program for Biotechnology and Pharmaceuticals began in 2007, chiefly built on and integrated the results of the program's first two phases, and conducted disease-oriented pharmaceutical R&D. Among the program's many promising results are the spin-off/establishment of the five companies, SynCore Bio, Efficient Pharma Management Corp., Oneness Biotech Co., Ltd., Aggie Bionatural Technology Co., Ltd, and Anchen Pharmaceuticals. The program induced companies to invest NT$1.4 billion, and the licensing of 31 technologies yielded NT$632 million in licensing fees. Furthermore, thanks to cooperation between the upstream NSC, the mid-stream MOEA, and the downstream DOH, ten domestic research results supported by the National Science and Technology Program for Biotechnology and Pharmaceuticals have passed the investigational new drug (IND) application processes. Three of these are undergoing phase 1 clinical trials and six are undergoing phase 2 clinical trials. The program achieved the following major outcomes in 2010:

(1) Transfering R&D results to industry

The National Science and Technology Program for Biotechnology and Pharmaceuticals (NSTPBP) employs a bridge program to transfer the research projects-derived results to industry and promote their commercialization, which serves to enhance the international competitiveness of domestic industry. The bridge program and the NSTPBP office serve as a bridge between academic research organizations and industry; project results are commercialized via technology licensing or industry-academic collaboration. In addition, the program serves as a communication bridge between inventors, their organizations, patent offices, and accepting firms, and assists with legal planning, negotiation strategies, and contract drafting, ensuring that research results can be successfully commercialized. The third phase of NSTPBP has completed 31 technology licensing cases, and a total of NT$632 million in licensing fees has been received (not including technology shares, royalties, and sub-licensing fees).

(2) Promoting corporate investment

The program plans industrialization applications strategies and commercialization models for technologies and product R&D results from academic researchers, and employs government incentives, assistance, and preferential policies in a flexible manner to assist academic and research institutes to achieve the commercialization of the program's R&D results via technology licensing, authorization, and collaborative development. The third phase of the program induced biotech and pharmaceutical firms to invest a total of NT$1.46 billion in 23 projects.

(3) Boosting new pharmaceutical R&D capabilities

Ten of the research results obtained under the third phase of the program have passed IND application procedures; of these, three are undergoing phase 1 clinical trials, six are undergoing phase 2 clinical trials, and one is expected to begin phase 1 clinical trials in 2011. Among the major cases, an IND application was made in June, 2010 to the U.S. Food and Drug Administration for the DBPR104 compound developed by the Institute of Biotechnology and Pharmaceutical Research, National Health Research Institutes, and the compound passed review on July 30, 2010. In September of the same year, an advisory conference with the Center for Drug Evaluation, Taiwan, was convened, and an application was made to the Food and Drug Administration, DOH, which was approved on November 24. It is expected that phase 1 clinical trials will be carried out at College of Medicine, National Cheng Kung University in early 2011. The compound in this case was screened and synthesized in phase 2 of this program, followed by a series of pre-clinical trials launched in the third phase, and technology-transferred to Sinphar Pharmaceutical Group. This successful case can be a model for domestic new drug development and enhance Taiwan's small molecule drug R&D. The implementation of all pre-clinical trials and completion of IND application documents relied entirely on domestic capabilities, showing that Taiwan has achieved international standards in the development of small molecule new drugs.

(4) Adopting IPR protections and establishing patent application mechanisms

In the face of international competition and challenges, protecting IPR of research outcomes and assembling patent portfolios has become a key means of maintaining international corporate competitiveness. After selecting R&D results with commercial potential, the bridge program helped the inventors make U.S. provisional patent applications, in order to take preemptive actions for patent application. The new operating mechanisms established by the bridge program will also reduce the administrative load involved in applying for patents in individual countries, and achieve a time advantages by assisting domestic academic and research institutes to make patent application to the Patent Cooperation Treaty.

(5) Integration of up-, mid-, and downstream resources

The third phase of the program is focusing on disease-oriented R&D concerning Chinese herbal medicines, new drugs, and biotech pharmaceuticals. Industrialization of research results together with stimulating the development of the domestic biotech pharmaceutical industry rely on cooperation between the upstream NSC, the mid-stream MOEA, and the downstream DOH. The following are some projects that have yielded important results:

a. A diabetic wound healing drug－WH1

The "Diabetic Wound Healing Drug and Rheumatoid Arthritis Drug Development Project" conducted by the Development Center for Biotechnology developed the natural extract drug WH1, which can promote healing of diabetic wounds. WH1 was extracted from patchouli (*Pogostemon cablin*), a traditional Chinese herbal medicine routinely used to soothe and heal burns. Due to their long-term difficulty in controlling glucose level, diabetes patients often suffer from vascular and neural lesions. Patients often are unaware of an external injury and are prone to have blood vessel narrowing or congestion in lower limbs which can significantly reduce blood supply to their foot. A combination of the above may cause severe infections in the foot and form wounds or ulcers which do not heal properly. Necrosis may set in and require amputation in severe cases. Based on their personal experience in the herb and literature reviews, researchers hypothesized that the constituents of patchouli might be effective in resolving poor diabetic wound healing; hence an animal model was used to find the components in patchouli that could most effectively promote wound healing in diabetes patients. In this effort, they relied on the drug development capabilities of the Development Center for Biotechnology to complete all preclinical tasks needed. At present, the sole drug approved in the U.S. for healing of diabetic wounds is the protein drug Regranex Gel

(Becaplermin 0.01%), which contains a genetically engineered platelet-derived growth factor receptor (PDGF) that may increase risk of cancer. While WH1 has similar effects in promoting diabetic wound healing to Regranex, its mechanism of action does not entail the risk posed by growth factors. In addition, WH1 is inexpensive and stable, does not require refrigeration, and has a long shelf life, making it a highly competitive product. The results of this project were licensed to the MicroBio Co., Ltd. by the Development Center for Biotechnology in 2007, which was then transferred to a subsidiary of MicroBio, Oneness Biotech, in 2008 for continued development. Oneness Biotech obtained permission from the U.S. FDA for phase 2 human trials in 2008 and began implementation. If this drug can be successfully commercialized in the future, apart from benefiting great numbers of diabetes patients, it will also provide Taiwan's biotech industry a model of how research on traditional Chinese medicine can yield profitable new drugs.

**A research team at the Development Center for Biotechnology used the patchouli extract WH1 as a natural drug promoting wound healing in diabetes patients. Due to low cost, good stability, and long shelf life, it will be a highly competitive product.**

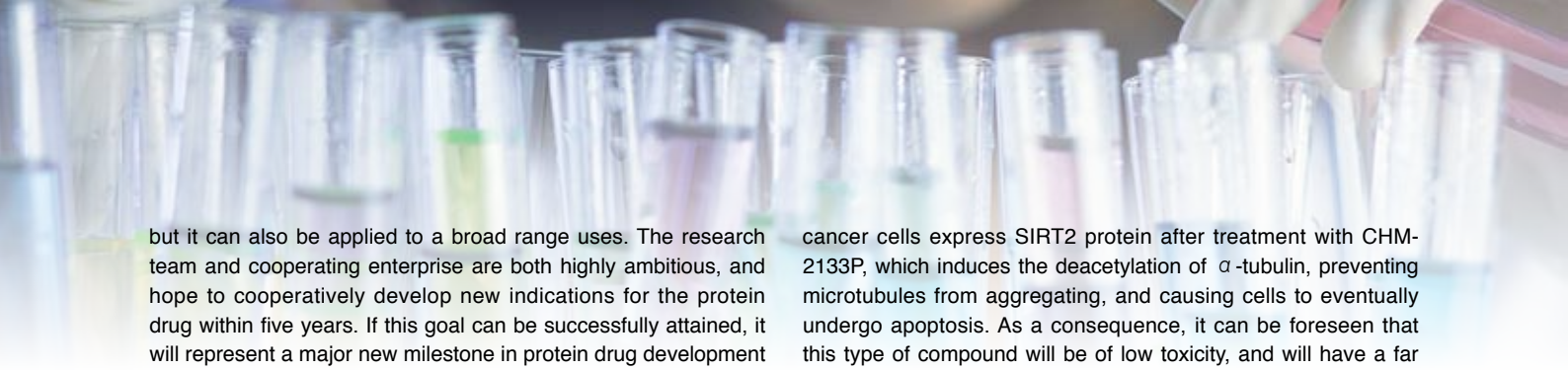
**Source: Development Center for Biotechnology**

b. A novel small molecule anti-cancer drug－DBPR104

A new small-molecule-targeted oncology drug R&D project conducted by a team at the Institute of Biotechnology and Pharmaceutical Research, National Health Research Institutes, developed two small molecule anti-cancer drugs (DBPR104 and DBPR204), of which DBPR104 is a novel, patented candidate drug selected from active lead compounds following a series of rational drug optimization operations after active lead compounds were chosen from a molecular library containing more than 20,000 substances using high-speed drug screening technology. This compound not only displays a high level of anti-cancer activity against many types of in vitro tumor cell lines, but can also overcome cancer cells with drug resistance induced by ordinary chemotherapy. Furthermore, DBPR104 displays a high level of tumor suppression ability in mice animal models with induced cervical and gastric cancers. Not only can DBPR104 inhibit the division of cancer cells, it can also suppress the growth of cancerous tissue by blocking its nutrient supply. In other words, DBPR104 has dual effects consisting of killing tumor cells and inhibiting the growth of blood vessels. In August 2008, the technology developed in this project was transferred to the Sinphar Pharmaceutical Group, which established the Syncore Bio to continue the development of the two drugs discovered. In particular, DBPR104 is the first drug developed jointly in Taiwan by domestic industry, government, academia, and the research community that has completed the steps of new drug investigation, preclinical toxicology, raw material drug production, preparation production, phase 1 human clinical trial design, drug master file application, and IND trial new drug application. DBPR104 received IND approval from the U.S. FDA in 2010 as a novel small molecule drug. In addition, Syncore Bio has already applied to the Food and Drug Administration, DOH for IND expedited review, and expects to begin phase 1 human clinical trials in early 2011 for safety assessment and pharmacokinetics research. After being selected from the compound screening process and synthesized in phase 2 of this program, DBPR104 underwent a series of preclinical trials in the third phase, and the technology was then transferred to Syncore Bio, which continued to collect information concerning the compound from commissioned domestic preclinical services. DBPR104 has now received approval for U.S. clinical trials. The fact that the entire new drug development process was completed in Taiwan relying on domestic resources demonstrates that domestic pharmaceutical firms have the internationally-competitive ability to develop new drugs, and pioneers a drug development model for up-and-coming new firms in Taiwan.

c. An $\alpha v \beta 3$ integrin antagonist－RD

A joint research team from the Department of Pharmacology, College of Medicine, National Taiwan University and National Cheng Kung University implemented the project "Use of RD Protein and its Derivatives to Treat Bone Cancer, Osteoporosis, and Osteoarthritis." Building on past research concerning snake venom in Taiwan, this project has sought to develop integrin antagonists for use in medical applications. Integrin is an important adhesion molecule on the cell membrane, chiefly responsible for the interactions between cells and the intercellular matrix. There are more than 20 types of integrin in humans, and all are composed of $\alpha$ and $\beta$ subunits. It is thought that the antagonist to integrin $\alpha v \beta 3$ possesses most clinical drug development potential. Since integrin $\alpha v \beta 3$ is related to angiogenesis and the proliferation and metastasis of many types of cancer cells, international pharmaceutical companies have also developed small molecules or monoclonal antibodies that can serve as an antagonist to integrin $\alpha v \beta 3$, and are using these drugs in clinical trials involving treatment of melanoma, prostate cancer, pancreatic cancer, rectal cancer, lung cancer, and brain tumors. This research team applied genetic engineering to a snake venom protein to alter the specificity of that protein, yielding an $\alpha v \beta 3$ antagonist in a unique technological breakthrough. The protein drug developed in this project can be used to treat diseases involving $\alpha v \beta 3$ abnormalities, and it may be used to fight tumors, angiogenesis, and osteoporosis. Many types of cancer cells that have metastasized into bones depend on osteoclast activity to maintain their growth. At present, while disphosphonate drugs can be used to inhibit osteoclast activity in cases of cancer metastasis into bones, the new drug developed in this project can simultaneously inhibit osteoclast activity and the new blood vessel growth required by growing tumor cells. No drug currently on the market possesses these two dual effects; not only can the drug inhibit the growth of bone tumor, it can also reduce bone fragility and hypercalcemia caused by tumors. As a consequence, the protein drug offers a new option for the treatment of cancer metastasis to the bones. The technology resulting from this project was licensed to Anchen Pharmaceuticals in 2008. A joint industry-academic collaborative project with Anchen was implemented in 2009 and 2010 to develop new indications and 2nd generation drugs outside the scope of the licensing agreement. Not only is the protein drug technology platform developed in this project highly innovative,



but it can also be applied to a broad range uses. The research team and cooperating enterprise are both highly ambitious, and hope to cooperatively develop new indications for the protein drug within five years. If this goal can be successfully attained, it will represent a major new milestone in protein drug development in Taiwan.

d. A novel small molecule anti-cancer drug－CHM-2133P

A research team at China Medical University conducting the project "Development of Potential Bioactive Compounds as New Drug Candidates" has discovered the small molecule compound CHM-2133P, which possesses anti-cancer potential. Although the team initially encountered many difficulties, such as weak activity in preliminary compounds and poor solubility, the team's specialists shifted gear, received outsourced assistance, overcame all the problems they faced, and eventually discovered this novel candidate drug. This new drug R&D process, in which the research team prevailed over difficulty after difficulty, shows the value of national science and technology programs in deriving early research results. In comparison with drugs currently on the market, CHM-2133P possesses multiple-targeting anti-cancer mechanism and is an IGF-1R inhibitor. It was also found that cancer cells express SIRT2 protein after treatment with CHM-2133P, which induces the deacetylation of α-tubulin, preventing microtubules from aggregating, and causing cells to eventually undergo apoptosis. As a consequence, it can be foreseen that this type of compound will be of low toxicity, and will have a far lower incidence of side effects than ordinary anti-cancer drugs. CHM-2133P can strongly inhibit breast cancer, ovarian cancer, brain tumor, colon cancer, and other types of cancers, and animal model studies have verified that it can prolong the lifespan of mice with tumors. Therefore, this drug has great market potential, and can be commercialized as a new-generation targeted cancer therapeutic agent. If the results of this project can be transformed into a commercial product, the research team's R&D process will provide Taiwan's academic and industrial researchers a model for the development of small molecule drugs. The project's results were licensed to the Efficient Pharma Management Corp. in 2010, and this company's drug development team then quickly completed preclinical testing. Efficient Pharma also plans to perform human trials at an early date in order to provide a new weapon in the fight against cancer.

**Major Results of Phase III of the National Science and Technology Program for Biotechnology and Pharmaceuticals**

| Item | 2007 | 2008 | 2009 | 2010 | Total |
|---|---|---|---|---|---|
| Academic papers | 80 | 89 | 97 | 115 | 381 |
| Training for Ph.D. and M.S. students (persons) | 279 | 343 | 405 | 409 | 359 |
| Patents received | 21 | 22 | 18 | 39 | 100 |
| Technology transfer (cases) | 6 | 9 | 11 | 4 | 30 |
| Technology transfer contract value (NT$1,000) | 75,454 | 421,292 | 89,660 | 43,475 | 629,881 |
| Corporate investment promoted by program (NT$1,000) | 14,021 | 825,498 | 562,138 | 54,800 | 1,456,457 |

[1] Statistics to December 2010

### 6. National Research Program for Genomic Medicine

The second phase of the National Research Program for Genomic Medicine (NRPGM, 2006-2010) will continue to build on the key aspects of the first phase—genomics, proteomics, and bioinformatics—while further focusing on the prevention, diagnosis, and treatment of Taiwan's three leading diseases—cancer (particularly liver and lung cancers), infectious diseases, and highly heritable diseases. The core facilities established under the program are providing high-quality services to genetic medicine research, while also developing cutting-edge technologies. NRPGM received funding of NT$1.45 billion in 2010, and achieved the following major research results:

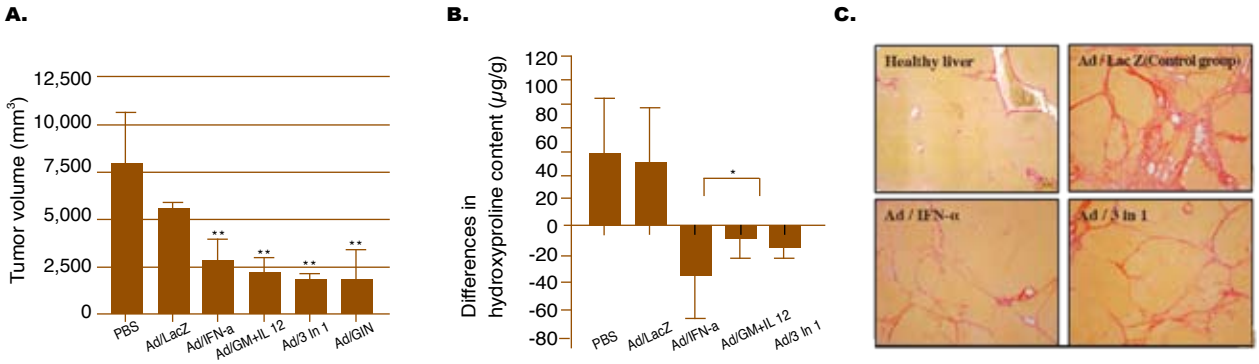
(1) NSC

a. Research projects

Clinical reports indicate that approximately 70-80% cases of liver tumors are accompanied by cirrhosis, therefore designing a therapeutic strategy that can simultaneously treat liver tumor and cirrhosis is extremely important. Experiments have found that when three adenovirus vectors respectively expressing IFN-α, GM-CSF, are IL-12 are delivered into the liver, they are highly effective in treating liver tumors and possess a multiplier effect. At the same time, they can simultaneously treat cirrhosis. Furthermore, researchers have found that when all three genes are carried on a single adenovirus vector, they can exert a similar therapeutic effect. The findings of this project have been published in the *Proceedings of the National Academy of Sciences of the United States of America*.

Functional genomics research on regenerated myocardial cells derived from stem cells discovered that the human and mouse myocardium possesses the ability to regenerate. Stem cells begin to repair the mice heart and regenerate the myocardium within seven days post-damage, but this repair mechanism stops within 10 days. A statistical study of the efficiency of stem cell regeneration of the myocardium indicated that 16% of the myocardium in the vicinity of injury area was differentiated from stem cells. This phenomenon does not exist in aged mice. The findings of this project were published in *Circulation*.

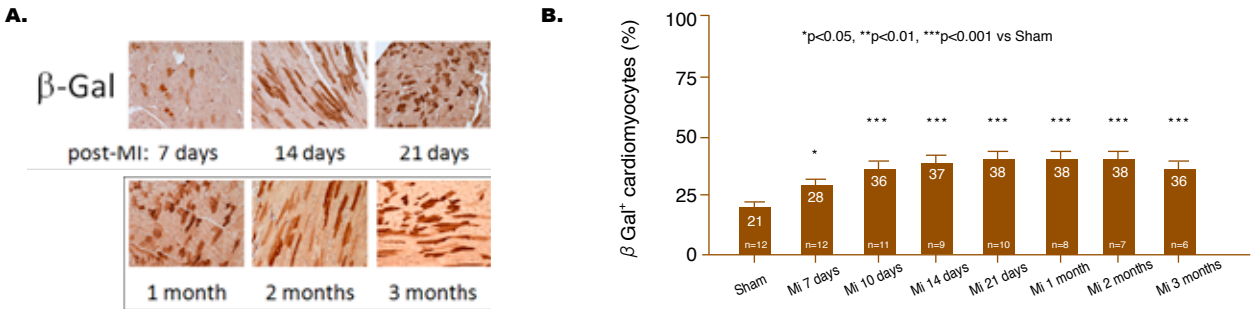
In industrial-academic collaboration, three pilot industry-academic collaborative projects were conducted during 2010. Of these, "Development of a High-Sensitivity Molecular Identification System Using a Novel Heparin Binding Motif" was a new project implemented in collaboration with MagQu Co., Ltd. This project employed genetic engineering, protein engineering, and animal experiments in conjunction with forward-looking superconductor and magnetic nanoparticle synthesis technology to develop new biomedical materials with heparin binding motifs, and used these materials to perform in vitro molecular identification of polysaccharides and in vivo MRI diagnosis. In international




**A. With the same total viral dose, the simultaneous use of three adenovirus (Ad/3 in 1) and use of one three–in-one adenovirus (Ad/GIN) can both achieve a multiplier effect in the treatment of liver tumors. B. The difference in hydroxyproline content expresses the effectiveness of cirrhosis treatment; the larger the negative value, the more effective the treatment. C. Sirius red dye indicates the extent of cirrhosis. Results B. and C. displayed that the Ad/3 in 1 treatment is effective, and exerts a multiplier effect in reducing cirrhosis.**

**Figures provided by Professor Lih-Hwa Hwang, Institute of Microbiology & Immunology, National Yang-Ming University.**

**Source: *Proc. Natl. Acad. Sci. USA*. 107(33): 14769-74, 2010.**




**A. Cell lineage tracing was used to observe the distribution of myocardium derived from stem cells bearing the β -Gal reporter gene at different time points post heart damage. B. Chart of β -Gal + myocardium.**

**Figures provided by Professor Patrick C.H. Hsieh, Graduate Institute of Clinical Medicine, National Cheng Kung University.**

**Source: *Circulation*. 122: S132-41, 2010.**



cooperation, three Taiwan-German collaborative liver cancer projects were conducted during 2010.

b. Core facilities

Fifteen core facilities in NRPGM were fully open to provide service during 2010 and have accommodated a total of 2,121 person-times from November 2009 to October 2010. These services are equivalent to NT$125 million, which was an increase compared with 2009. The services provided by the core facilities have attained international standards, and research personnel from the University of Singapore, the United States' Memorial Sloan-Kettering Cancer Center, and the Optimer Pharmaceuticals Co. (US) have applied for services.

The five central missions of the core facilities consist of service, joint research, technological R&D, education/training, and promotion of technology, and have significantly raised the standards of genomic medicine in Taiwan since they were initiated in 2002. The following are some major results achieved by the core facilities in 2010:

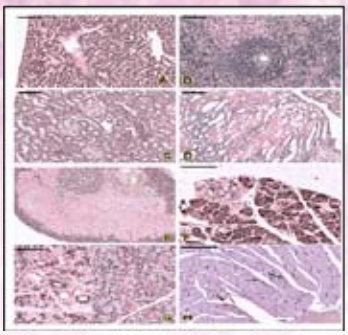
A total of 83 academic articles issued by the core facilities were published in domestic and international journals in 2010. The project "Estimation of the Warfarin Dose with Pharmacogenetic Data," in which the High-Throughput Genotyping Core and National Clinical Core for Genomic Medicine were participants, was a cutting-edge research effort encompassing 21 research teams in nine countries, and has resulted in numerous academic articles in high impact factor journals during the past two years. The research team targeted on the drug Warfarin, which is commonly used to treat thrombosis, and developed a precise dose estimation formula employing the VKORC1 and CYP2C9 genotypes in conjunction with factors such as height and weight, etc. Since the optimal Warfarin dose varies considerably from patient to patient, the resulting formula will greatly improve the quality of treatment for many diseases, and ultimately benefit countless individuals. The project's results have been published in the *New England Journal of Medicine*. Recently research has verified that several SNPs correlate with drug dose, and the SNP VKORC1-1639 alone has been shown to accurately predict Warfarin dose. This is one of the best examples of the progress in individualized and translational medicine being made in Taiwan.

In addition, another research project used mice with a mutated gene coding for palmitoyl transferase to analyze the molecular mechanisms of human conditions caused by defective palmitoylation, including hair loss, systemic amyloidosis, and osteoporosis. With employment of X-ray imaging, the researchers discovered that mice with mutations in the Kojak gene (-/-) suffered skeletal abnormalities such as kyphosis and osteoporosis, alopecia, and amyloidosis. The project's findings were published in the journal *PLoS Genetics*.

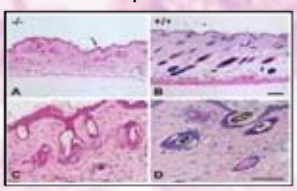
(2) Department of Health

Genomic research on lung cancer and clinical applications: Researchers discovered a new cancer-causing mechanism of NNK (nicotine-derived nitrosamino ketone), which is a known major carcinogen in cigarette smoke, and provided further evidence that quitting smoking reduces risk of cancer. Apart from causing DNA damage and mutations, this project also found that NNK causes epigenetic alteration in the carcinogenesis process. NNK in lung cancer cells and the tissue of patients

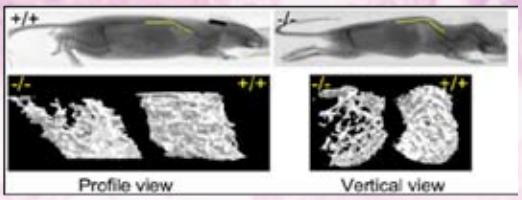
Systemic amyloidosis



Abnormial development of hair follicles



Hunchback, Osteoporosis




**Phenotype analysis of mice with mutations in palmitoylation genes showed that this mutation can cause alopecia, systemic amyloidosis, and osteoporosis. (left) systemic amyloidosis; (middle) abnormal hair follicles; (right) kyphosis and osteoporosis.**

**Figures provided by Dr. Jeffrey J.Y. Yen, Institute of Biomedical Sciences, Academia Sinica.**

**Source: *PLoS Genetics*, 6(6): e1000985, 2010.**

**Results of the National Research Program for Genomic Medicine, 2006-2010**

| Item | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|
| Academic publications | 679 | 403 | 323 | 331 | 327 |
| Patents applied for/granted | 19/21 | 26/16 | 8/22 | 13/13 | 19/21 |
| Technology transfer cases | 15 | 17 | 13 | 5 | 17 |
| M.S./Ph.D. student training (persons) | 600 | 340 | 407 | 373 | 383 |
| Conference/seminar participation (person-times) | 9,637 | 12,824 | 13,541 | 9,103 | 6,155 |

with lung cancer employs multiple mechanisms to induce increased expression of the DNA methyltransferase DNMT1. As a consequence, promoter hypermethylation of tumor suppression gene reduces the expression of tumor suppressor proteins, which is one of the lung cancer's initiation mechanisms. This project discovered a new therapeutic target in the case of tobacco-related diseases, and also offers scientific evidence backing up anti-smoking campaigns. The research findings have been selected as the cover feature of the February 2010 issue of *The Journal of Clinical Investigation*, and attracted coverage in the US media. The DOH held a press conference on the project, and the DOH Bureau of Health Promotion used the project's findings in its tobacco control work.

Assisting in the improvement of the legal and regulatory environment in connection with emerging areas of medical technology: The DOH reported on the application of genetic biomarkers in new drug R&D and clinical trials, assessed the influence of the *Statute For Human Body Biological Database Management* on drug clinical trials, and provided Revised Draft Recommendation Concerning the Guidance for Informed Consent Form of Pharmacogenetic Research.

The DOH issued the *Statute for Human Body Biological Database Management*, and submitted the *Clinical Trial Review and Assessment Procedures for Research Involving Specimen Collection* to DOH Food and Drug Administration as reference guidelines for review of technical data from clinical trials.

(3) Ministry of Economic Affairs

Development of biomarker kits for disease diagnosis: Development of an all-round liver disease diagnostic kit. Researchers completed development of a prototype liver disease/hepatic fibrosis biomarker kit and completed worldwide PCT (Patent Cooperation Treaty) patent application in 2009. The project team held a press conference on September 23, 2010 to formally announce its results; the technology licensing fee is NT$27 million, and it is expected that future royalties will amount to between NT$500 million and NT$1.5 billion.

Development of a prognostic assessment kit for cancer: This project relied on analysis of genetic changes in tissue to develop a risk assessment kit for recurrence of colon cancer, and has successfully developed a colon cancer recurrence probability assessment kit (employing a colon cancer recurrence risk index). The kit has been verified using 100 patients. Employing a six-candidate compound algorithm as an example, the AUROC is as high as 0.9651. It is hoped that the early identification of patients with a high likelihood of recurrence will enable active treatment and prevent tumor recurrence.

This program has transformed many leading-edge technological advances into strong international patent portfolios, enhancing the international competitiveness and product value of Taiwan's manufacturers. The program has completed 37 biomarker-related multinational invention patent applications, of which 12 have received certificates and one is in line to receive a certificate. Following completion of international patent portfolios, the new technologies will be transferred to manufacturers, assisting the creation of a high added-value molecular diagnosis industry in Taiwan.

### 7. Taiwan e-Learning and Digital Archives Program

This program was established in 2008 from the union of the National Digital Archives Program and National Science and Technology Program for e-Learning. The program's purpose is to make digital archives and e-learning information accessible to society, promote the creation of a knowledge society, and thereby achieve the ultimate goal of enhancing national competitiveness. The program aims to "diversify Taiwan's knowledge collections and deepen e-learning," and its goals consist of presenting Taiwan's cultural and natural diversity, promoting the use of archive content and technology in industry, education, academic research, and social development, establishing digital archives and e-learning industries, deepening the applications of e-learning in formal education and lifelong learning, enhancing Taiwan's international status in the field of language instruction, and promoting the globalization of digital archives and e-learning results in order to establish international collaborative networks. The program's eight subprojects focus on expansion of Taiwan's digital archives, development and integration of digital technologies, development of core digital platforms, extension

of the academic and social applications of digital archives and e-learning, fostering the development of digital archives and e-learning industries, promotion of digital education and online learning, development of digital language instruction, and overseas extension and international collaborative projects involving digital archives and e-learning. Twenty government agencies are participating in this program. The program received funding of NT$1.32 billion and achieved the following results in 2010:

(1) Production, display, and use of digital content

A cumulative total of approximately 3.02 million original collection items had been digitized to date, and 216,207 joint catalog items were digitized during 2010 (a cumulative total of approximately 6.68 million digitized media items have been produced). This program has developed digital instructional materials needed for classroom teaching from the elementary school to the university and college level, providing teachers with resources for use in digital instruction. At the same time, the program is developing e-learning resources able to enhance the cultural and artistic qualifications of workers, civil service personnel, and the general public. Instructional materials have been placed on e-learning websites providing users with unrestricted access. A total of 1,054 courses (1,442 hours) of digital instructional materials/courses were developed during the year.

In order to facilitate convenient public awareness and use of this digital content, the program is using a variety of methods to promote the diversified, accessible, global, and sophisticated presentation of program results. For instance, the program maintains an updated portal website (digitalarchives.tw), which features a field structure modeled after the Dublin Core Collections Application Profile (DCCAP). The portal website collects information from all program-related websites, which is arranged by classification, grouping, and user type. Users can browse information on various websites by topic and applicable target using a single platform, and can link to other websites in order to obtain further information. The program is striving to publicize project results via a digital archives and e-learning results portal website community that consists of the portal website and special topic/joint catalogs, a project results website resource library, and blogs. As of November 30, 2010, the results portal website had provided services to 2,705,893 visitors; browsing traffic increases significantly when the program introduces new special topics, publishes publicity articles, and holds results exhibitions.

(2) Academic research results and activities

A total of 581 papers resulting from work done under the program were published in 2010. Of these, 119 had been collected by the *Social Sciences Citation Index* (*SSCI*) , *Science Citation Index* (*SCI*) , *Engineering Index* (*EI*) , *Arts & Humanities Citation Index* (*AHCI*), or Taiwan Social Sciences Citation Index (TSSCI). The article "Audio Processing and Retrieval Technology" was published in the periodicals of the Institute of Electrical and Electronics Engineers (IEEE), Association for Computing Machinery (ACM), and International Conference on Multimedia and Expo (ICME); the IEEE and ACM periodicals have great prestige in relevant fields, and ICME is a major conference in the area of multimedia. This technical paper was accepted by ICME2010 as a verbal report at the conference--the ICME acceptance rate is only 15%. In addition, the paper "A Binarization Method with Learning-built Rules for Document Images Produced by Cameras" had an *SCI* impact factor of 3.279. The paper "Homomorphic Encryption-based Secure SIFT for Privacy-Preserving Feature Extraction" addressed the topics of encrypted image retrieval technology and privacy protection, which is a very rare subject in the literature.

With regard to academic activities, major international symposia held during the year included the 2010 International Conference on the Taiwan e-Learning and Digital Archives Program (TELDAP International Conference), which attracted 388 participants from 11 countries; the 84 presentations at this event covered such topics as digital restoration, literature and files, Taiwanese works scattered overseas, museums, maps and buildings, biodiversity, and e-learning. The 2010 International Conference: When Culture Encounters the Internet invited experts and scholars from around the world to engage in discussion and envision the future of culture and information technology, while also learning about this national program and arranging possible future collaborations.

(3) Research and development of advanced digital archive and e-learning technology

The 34 technology transfer cases in 2010 earned approximately NT$12.9 million in licensing fees and resulted in nine patents. The National Police Administration signed an NT$714,000 technology transfer contract for "Applied Technology for the Analysis of Internet Users' Multiple Identities." In the field of automated Chinese-language voice analysis technology, "Chinese Word Segmentation System" technology was transferred to the Bai Suo Network Technology Co., Ltd., and was also transferred gratis to the Information Engineering Department at Chiayi University and other academic organizations. With regard to patents, "Front-end Detection System and Method for Voice Identification" received ROC and PRC patents, "Interactive Ecological Multimedia Teaching Device" received an ROC patent, and "Method and System for Providing Mobile Information, and Its Server and Portable Device" received a US patent.

Major digital archives technology R&D results included the introduction of version 2.64 of a Chinese character formation database, which has collected a total of 143,173 ancient and modern Chinese character forms and has thus far been downloaded more than 20,000 times. Research on encrypted image retrieval methods incorporated a compression framework to achieve an innovative confidential retrieval method. Research on video color correction technology for the color-blind in an image and video content analysis project sought to strengthen the difference between color-blind video and raw video data so that color-blind individuals can distinguish color and contrast information after the conversion. Research on automatic geographical digitization technology enabled collecting units to automatically position database content on maps, allowing integrated presentation of geographical data. Research on the inclusion of concealed messages in cascading style sheet (CSS) files enabled the extraction of secret information from CSS files, which can thwart intruders by preventing file thieves from masquerading as the file writer.

Important e-learning technology R&D results and applications included the development of semantic-linked retrieval technology and the establishment of an automatic Chinese terminology labeling database. This project found more than 700,000 Chinese terminology items on the Internet (including approximately 45,000 commonly-used Chinese vocabulary items) with a labeling accuracy of 90%, which exceeds the accuracy of

Yahoo! Research on new e-book technology developed e-book cloud computing technology, e-book cloud computing upload technology, and geometric computing technology.

(4) Scientific development results announcement and publicity

Apart from holding a conference to announce 2009 results and participating in publicity activities such as the 2010 Taipei International Flora Expo, the program also published the 3rd and 4th "Guide to the Results Portal—Creative Issue" and the Chinese-English "Digital Archives and e-Learning e-Bulletin," which communicated the program's newest results to the public.

**Participation in the "A Flora Enlightenment" exhibit at the "2010 Taipei International Flora Expo." This exhibit, which publicized the plants and flowers in the nation's digital archives, received a rousing response from the public.**

**Source: Taiwan e-Learning and Digital Archives Program office**

(5) Use of digital archives in social and industrial applications

In order to encourage the user community, including the public, schools, and research units, to use digital archives technology and knowledge, the government is promoting the release of digital archives and related knowledge for public use and sharing. Furthermore, the growing digital archives industry is fostering the digitization of elements worth collecting, which is achieving the goals of preservation and extension. An addition, source materials can be readily transformed into valuable products or services by various industries via creative development and innovation models and alliances between different industries. Apart from promoting industrial development and economic benefit, the application of digital archives can also enchance quality of life.

a. Social applications

The sample digital archives extension book "Storing the Wealth in the People" uses appealing, accessible text and pictures to teach readers about digital archives, and it brings to life the process between collection and extension. The lavish illustrations and well-written text of this book will make general readers aware of the concept and results of digital archives use. Apart from 1,800 copies printed for free public distribution, the entire content of the book can be uploaded from the program website for free public reading. In an effort to reduce the digital divide in indigenous villages, the program also promoted use of a digital archives database concerning indigenous issues in urban areas and indigenous communities in the Taoyuan-Hsinchu-Miaoli area, and also offered extension classes on digital archives. By enhancing the effectiveness of indigenous cultural/economic industries, this effort will provide a sustainable model for indigenous village industries.

b. Industrial applications

The program accepted a total of 36 e-learning/collection/Chinese-language project funding applications in 2010, and provided a total of NT$151.6 million in funding to 23 companies. The funded projects yielded an increase of NT$317.3 million in output value, and the funding also stimulated NT$160 million in digital archives and learning industry investment. Transcending past collaboration models involving collecting organizations (supply end) and companies (application end), this year saw the introduction of innovative collaboration models including joint product design, joint content design, joint venue design, use of integrated channels, in dual brand cooperation. As a result, value-added products derived from collections exhibited increased diversity and became even more accessible to the public.

The program promoted the use of new technologies and site-specific applications to display collected resources and create new types of consumers and viewers. This increased companies' revenues while also innovating new knowledge transmission methods. In the project "Use of Digital Archives to Develop an Intelligent Restaurant," Hsing Tienti International, Polygon Works, and the Academia Sinica combined digital archives resources concerning fish and shellfish with seafood restaurant operation, and used augmented reality and virtual reality digital applications technology to create a new collaborative social education conceptual space model.

The program's promotion of collaboration between companies and collecting units led to the creation of new cultural assets, such as via the value-added utilization of images and development of a wide range of new products. For instance the program assisted the Champion Building Materials Co., Ltd. (a traditional manufacturer) to apply for dual brand cooperation with the National Palace Museum; Champion employed details from bronze artifacts in the museum's digital archives to develop in two stages high-end tiles and tile-derived furnishing products. The program also assisted Hua Kang Cinema (a digital content company) to use images from the collections of the Chinese Taipei Film Archive and Lin Liu-Hsin Puppet Theatre Museum to develop all-new mixed media images combining creative elements from puppet opera and film.

(6) Development and promotion of the e-learning industry

The program collected and newest domestic and foreign advances and successful cases for the reference of domestic companies, and assisted companies to establish commercial models and operate profitably or attract investment by other companies. At the same time, the program also assisted companies to develop innovative e-book business models and integrated services, and helped firms to enter international markets and take advantage of international business opportunities by fostering participation in international exhibitions and sales promotion activities. The program's assessment of companies' digital teaching materials and e-learning services ensured that these products and services met certain quality standards.

Deepening the applications of e-learning, assisting industry to enter international markets: The program helped the CyberLink Corp.'s "Training Master 7" e-learning management system and e-Learning 2.0 module to win the Excellence in Learning Technology Award granted by America's Brandon Hall; the fact that Brandon Hall is considered on a par with such prominent e-learning firms as Sun Microsystems and Cisco shows that the results of the program's assistance efforts are attaining international recognition. Furthermore, the program helped the

Idealist Information Co., Ltd. to apply to enter the NHK's Japan Prize; Idealist was selected as a finalist in the children's learning product category, which earned international recognition for its products.

Assistance for innovative e-book business models and integrated services: The program enlisted the services of domestic hardware, e-learning, and publishing companies in an effort to develop integrated learning application services, and extended the results to schools, libraries, training units, and the corporate learning market. Roughly 25 firms participated in this work during 2010, and the program assisted several companies to develop and transform themselves into educational e-book service firms. The first E-ink and LCD-based educational e-books in Taiwan were introduced (HiAChieve Digital Technology's eWonderPad and Chien Hua Learning Resources' iSmart learning device), enabling elementary schools, junior high schools, high schools, colleges and universities, and adults to use mobile learning products and services. As a result, the overall value of relevant learning products and services has exceeded NT$5.4 billion. The program also conducted user behavior analysis and trial use in teaching systems and internal corporate training, which will help bring about the transformation of the domestic learning industry.

Promoting quality in e-learning: The learning conducted a questionnaire and interview survey to gauge the effectiveness of e-learning quality certification and the value expected of certification. During 2010, 73 applications for quality certification of e-learning instructional materials had been accepted up to December 10, and 34 items had passed certification.

(7) Development and promotion of Chinese-language e-learning

In keeping with the with nation's policy of promoting the export of Chinese-language materials and knowledge innovation, the program enlisted the support of Taiwan's information and communications industry, promoted the development of innovative digital technologies and learning models, and encouraged the transformation of Taiwan into a global center of Chinese-language learning technology and content production, and encouraged efforts to give Taiwan a unique brand image in the field of Chinese-language instruction.

Maintenance and improvement of the "HuayuWorld" Chinese-language website: In order to focus the efforts of different agencies and enhance Taiwan's international competitiveness, program's digital language instruction project has established a global Chinese-language website (http://www.huayuworld.org/) to serve as an international Chinese-language e-learning portal. This website contains comprehensive Chinese-language learning services and contains a teaching material resource library, teacher blog area, and exceptional Chinese-language product promotion area. As of the end of December 2010, the HuayuWorld website's front page had been visited a cumulative total of more than 4.61 million times, and browsers hailed from 159 countries worldwide. Over 12,800 blogs have been established on the website, and there are 4,842 Moodle instructional courses.

Skills training for Chinese-language instructional personnel: The " 2010 Chinese-language Online Seed Instructor Training Project" conducted a special hands-on class in the Australia / New Zealand / South Africa area, four sessions of an online basic training class, and two sessions of an online advanced training class. Training was provided to a total of 262 trainees from various countries. After completing training, the trainees have been active promoting Chinese language instruction in their home countries.

Assisting overseas Chinese schools and Chinese language schools to become "Chinese language e-learning centers": In 2010, "Chinese language e-learning center" demonstration and teaching locations were establish in Jordan, Brisbane in Australia, Seattle and the San Francisco Bay area in the United States, and Porto Alegre in Brazil. A total of 51 "Chinese language e-learning center" demonstration and teaching locations have been established since 2007. Thanks to professional assistance and the creation of a successful operating model, these centers have been highly effective and are yielding increasingly positive results.

Transmission of Hakka language and culture: The "Hakka Online Academy" website relied on its "Hakka Heat Wave" feature to encourage citizens and foreigners to encounter and understand Hakka language and culture. The website is promoting communication and harmoniously between groups in society, promoting a multicultural atmosphere in society, gradually accumulating cultural assets of various types, and ensuring that Hakka culture continues to thrive. As of December 20, 2010The website had been visited over 2.2 million times, and had more than 50,000 members from 1,193 cities in 80 countries.

(8) International cooperation and extension

In order to promote the program's many years of accumulated digitization results in the international sphere, the foremost task is to provide multilingual translations of digitized resources, which are chiefly in Chinese. At the same time, in order to reduce loss of artifacts and enhance the integrity of domestic research resources, the program is relying on international collaboration to find and gather Taiwanese works dispersed overseas. The program is also employing collaboration and alliances with various countries to accumulate international contextual resources and achieve the goal of international resource sharing.

Multilingual translation of collection catalogs and content in order to enhance the visibility of Taiwan's digital archives results: The program is gradually promoting the multilingual translation of the most valuable digital archives resources and content of the joint catalog. Taiwan's major digital archives resources are being translated into English, Japanese, and Spanish, which will not only expand use of Taiwan's digital archives joint catalog and resources, but also propel Taiwan's digital archives results into the international sphere, boosting the visibility of the country's digital archives on the international stage.

Collection of Taiwan's cultural and historical resources dispersed overseas, promotion of international resource sharing: The program is relying on international cooperation to gather valuable collection resources dispersed overseas; these items, which are currently in the collections of organizations including libraries, archives, and museums, are diverse in form and content, and include such important cultural assets as physical artifacts, literature, models, and specimens. These items can enrich digital archives databases, digital content knowledge libraries, and Taiwan's existing collections, and will provide important resources for research in many areas; they will also improve the domestic academic research resource environment and promote international resource sharing. Starting in 2008, the program has established cooperative relationships with 96 organizations in 14 countries, including the German of Natural

History, Korea's Min Molluscan Research Institute, Australia's Griffith University, the US Library of Congress, Britain's King's College, and the French Museum of National History.

Establishment of an international cooperation network, sharing of collection resources and learning tools: (1) International cooperation and research projects connected with Taiwan's domestic fish digital archives: Apart from modifying the domain name of Taiwan's mirror site and upgrading the site's statistical software in conjunction with the international FishBase's integration needs, the program will help the FishBase office with deployment of the AquaMap database and improvement of its distribution map rendering function. Furthermore, via the recommendation of Dr. Froese, the program will provide data from Taiwan's "Seafood Guide" to the international Seafoodguide. (2) Offering international online courses on subjects connected with e-learning: The program began offering international online courses starting in March 2010. These courses have not only channeled international academic resources back to domestic researchers and training outstanding international e-learning manpower, but also established extensive links between e-learning theory and practice. Apart from enabling researchers to conduct groundbreaking research, the courses have further created a solid cooperative international e-learning foundation and accumulated practical experience.

Establishment of strategic alliances with partners in leading nations, joint promotion of global digitization cooperation: The program is participating in Chinese translation work for the Art & Architecture Thesaurus (AAT) project in collaboration with the Getty Research Institute, and had completed translations for 32,000 terms by the end of 2010.

## D. Research Results of the National Synchrotron Radiation Research Center

The National Synchrotron Radiation Research Center (NSRRC) was established to construct and make effective use of the country's synchrotron accelerator and peripheral research facilities, support nationwide academic research, encourage industry, academia, and the research community to perform cutting-edge research, and training high-tech manpower This year the existing Taiwan Light Source (TLS) operated stably, the number of researchers using radiation continued to grow, and many outstanding results were achieved. The center's Taiwan Photon Source (TPS) synchrotron accelerator construction project has entered the construction stage and is proceeding in accordance with the preset timetable.

### 1. Accelerator facility

The existing TLS accelerator operated continuously and stably 24 hours a day; total operating time was 7,037 hours, and operating efficiency was 97.4% in 2010. The electron beam's stability index was 95.6%, which met the preset target for the year.

The center took advantage of a long operation stoppage period from February 12 to March 31 to complete installation of a third IASW (in-achromatic superconducting wiggler) magnet and its front-end area, X-ray beam position monitor (XBPM), and vacuum system, and trial operation was completed successfully. NSRRC is currently installing a biopharmaceutical protein crystallography beamline obtaining radiation from this source; trial operation of this beamline is expected to begin in February 2011. NSRRC is also conducting new accelerator technology R&D, and has developed a low-emittance, high-frequency, laser driven electron gun. The subsystems of the laser driven photocathode electron gun testing platform have been installed and tested, and has functioned normally. The ultra-high vacuum seals of the photocathode high-frequency electron gun are currently being manufactured, and will be installed and tested after they are completed.

### 2. Peripheral experimental facilities

NSRRC continued to operate, maintain, and upgrade beamlines throughout 2010; beamline energies included infrared, UV, soft X-rays, and hard X-rays. The center currently has 27 operating beamlines (including 25 at the NSRRC site and two at Japan's SPring-8); two beamlines completed trial operation and were expected to opened for use in the first quarter of 2011 (both at NSRRC); three beamlines were still in trial operation (two at NSRRC and one at SPring-8); and one beamline was under construction (at NSRRC). A circular dichroism (SRCD) beamline (beamline BL04C1) was completed during 2010 and began producing radiation. After the completion of luminous flux, spot image, and dimensional measurements, SRCD standard spectrum operation will begin. In the future, after biological specimen experiment stations have been installed, this beamline will be made available to domestic and foreign life science researchers.

Since the Taiwan Photon Source synchrotron accelerator is expected to be completed in 2013 and go into use in 2014, planning of peripheral experimental facilities has already gotten underway. A Chinese-English conceptual design report for stage 1 beamline design has been completed, and a timetable and funding needs have been drawn up. In addition, NSRRC has solicited stage 2 peripheral experimental facilities from various interested parties, and hopes that experimental facilities will conform to international trends while also accommodating users' needs and innovative ideas.

### 3. User extension and scientific research

A total of 1,306 advanced research projects (9,913 person-times/200 research teams) used NSRRC's light source during 2010; these projects were sponsored by 91 domestic and 140 foreign organizations. A total of 68 user teams used biological crystallography facilities. Areas of research at NSRRC encompassed atomic and molecular science, condensed state physics, materials science, soft materials, biological structures, nanometer fabrication, and industrial applications. Users published a total of 273 SCI-cited papers in international scientific journals, including 209 papers published in prestigious journals with an impact factor greater than two. Eighteen papers with impact factors greater than six were published in leading journals, including the papers "Finding a New Family of Control Actins through the Use of CPI Fragments in Structural Research," which used a protein crystallography experiment stations (experiment station 13B1) and was published in *Nature Structural & Molecular biology*"; "Discovery of New Chemistry Involving Eutectic Solvents," which used an X-ray powder diffraction experiment station (experiment station 01C2), and "Synthesis of Novel Uranium Silicates and Valence State Analysis," which used an X-ray absorption spectrum experiment station (experiment station 01C1), were published in the German periodical *Angewandte Chemie-International Edition*; "Structural Changes in the Bonding of Staphylococcus TcaR Protein and Antibiotics" used a protein crystallography experiment station (experiment station 13B1)

and was published in the *Proceedings of the National Academy of Sciences (PNAS)*; and "A New Breakthrough in Oxidation of Gallium Nitride with Gold" used an eight-ring X-ray diffractometer experiment station (experiment station 17B1), and was published in *Advanced Materials*.

NSRRC holds annual user conferences in order to boost academic interchange between domestic and foreign research personnel working in the field of synchrotron radiation, and promote communication with users. The 16th Annual NSRRC Users' Conference and Synchrotron Nanoscopy Seminar was held October 20-22, 2010. A total of 532 persons attended this event, and 237 wall posters described research results. Domestic and foreign experts were invited to speak at this event, and users presented their research results; this conference was held entirely in English. The speakers' insightful presentations gave the participants a clear understanding of the current state and potential role of synchrotron accelerator radiation in nanotechnology, and stimulated much enthusiastic discussion. The conference also provided many opportunities for cooperation between different units and inspired numerous innovative research concepts. NSRRC believes that the discussion of cutting-edge experimental methods and topics at the seminars will greatly facilitate the design and use of beamline and experiment stations at the future Taiwan Photon Source.

**4. Collaboration with industry**

This year firms used NSRRC's light source to perform materials analysis and testing 17 company-times, and beamline time used for materials analysis accounted for 6% of light source operating time. During 2010, apart from the completion of many testing projects commissioned by industry, major high-tech firms also signed contracts with the NSRRC for the establishment of their own dedicated beamlines, which will be used for long-term commissioned research work. A seminar concerning the industrial applications of synchrotron radiation was held September 2-4, 2010; the close to 200 participants from industry and academia engaged in avid discussion at this very productive event.

**5. Manpower training**

In order to promote the application of synchrotron radiation, NSRRC offers degree programs in conjunction with National Tsinghua University and National Chiao Tung University. The former programs include "Advanced Light Source Technology" and "Structural Biology"; the latter consists of "Accelerator Light Source Technology and Applications." The center continued to implement these Ph.D. and M.S. training programs in order to provide more young technical manpower. In order to promote synchrotron radiation experiments and synchrotron light source research, university professors are also actively encouraged to teach on an adjunct basis at NSRRC.

**6. New light source and outlook**

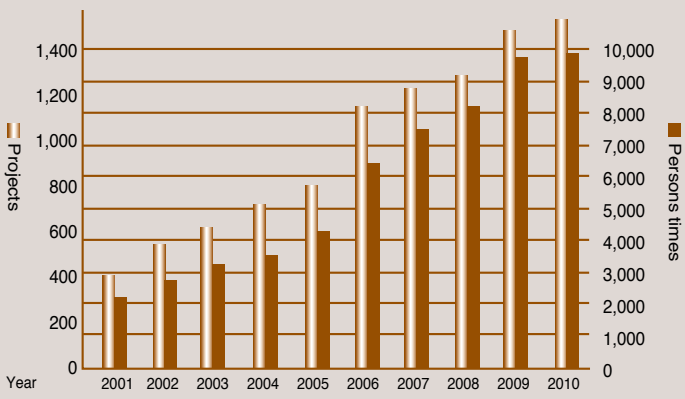
A groundbreaking ceremony for NSRRC's major national project "Taiwan Photon Source Accelerator Construction Plan" was held on February 7, 2010 after the construction application received the approval of the Science Park Administration. Construction is currently proceeding in accordance with the project timetable, and it is expected that civil construction and E&M work will be completed in 2012. The project calls for the construction of a medium-energy light source with a circumference of 518 meters and energy of 3 GeV. This is the largest multi-year "advanced common research platform" construction project in Taiwan's history. In conjunction with the soon-to-begin "Taiwan Photon Source Peripheral Experimental Facility Construction Project," the light source project will create one of the world's finest synchrotron accelerator radiation experiment facilities, provide academic researchers nationwide with a powerful new tool for forward-looking R&D, and offer many opportunities for interdisciplinary scientific research and technology.

## E. Research Results of the National Applied Research Laboratories

The National Applied Research Laboratories (NARL) was founded in June 2003 when national laboratories originally subordinate to the NSC were re-established as juridical persons for the purpose of enhancing their flexibility and efficiency. NARL currently consists of ten national experimental research units and one preparatory office (Taiwan Typhoon and Flood Research Institute Preparatory Office). NARL's headquarters arranges and coordinates the operations of its various units in order to fulfill its chief mission of establishing R&D platforms, supporting academic research, promoting forward-looking science and technology, and training S&T personnel. NARL had a total of 1,415 employees as of the end of 2010. The following is an overview of NARL's major results during the year:

**The BL04C1 circular dichroism (SRCD) beamline was completed in 2010.**

**Beamline experimental projects and user person-times statistics, 2001-2010**



**1. Establishment of advanced core technologies, achievement of service and manpower training synergy**

In order to achieve its goals of supporting national science and technology policies and promoting citizens' welfare, during 2010 NARL continued to integrate forward-looking technologies, develop advanced core technologies, generate major long-term results reflecting clear-cut objectives and significantly benefiting society, and maintain harmony with international standards. In conjunction with the development of science and technology, NARL is made creating the greatest possible value for Taiwanese society its overriding research objective.

The following are a few of NARL's many outstanding R&D results during 2010:

(1) The Instrument Technology Research Center (ITRC) participated in the 2010 (62nd) Nuremberg International Invention Exhibition, where it received four gold medals; research results concerning a toroidal metamaterial produced at the Center were published in *Science*.

(2) The National Center for High-Performance Computing's (NCHPC) high-speed computing team and a team from National Tsinghua University participated in and won first place at world-class high-speed computing marathon－the Student Cluster Competition; this competition is the world's most famous and most important international high-speed computing conference.

(3) The National Laboratory Animal Center successfully developed rat gene transfer technology, and transferred specially designed gene fragments into rats, creating the world's first controllable transgenic rat technological platform.

(4) The National Nano Device Laboratories developed the world's first and smallest 9 nm functional resistive random-access memory (R-RAM) array cells, which offer a capacity approximately 20 times greater than that of existing flash memory and power consumption roughly 200 times less. This new memory can store text data equivalent to an entire library in an area of only 1 cm2 with almost no energy consumption, and may dominate the NT$1 trillion memory industry during the next decade.

(5) The National Space Organization's FORMOSAT-2 satellite performed natural disaster survey, relief, and observation work, and the FORMOSAT-3 satellite performed global climate observations. The FORMOSAT-5 optical remote sensing satellite project, which will involve autonomous Taiwanese satellite development for the first time, calls for the development of a high-resolution remote sensing payload embodying the features and competitiveness of Taiwan's high-tech industry. The goal of this project is to establish autonomous satellite bus development capabilities and develop major key elements. It is expected that, after many years of operation, the FORMOSAT-2 satellite will continue to provide black-and-white ground images with a resolution of 2 m and color images with a resolution of 4 m over 24-kilometer swaths. The Space Program also completed launch of Sounding Rocket-7 and onboard scientific experiments.

(6) The National Science and Technology Center for Disaster Reduction developed flooding early warning technology and a typhoon survey mechanism, and promoted disaster mitigation work in northern, central, and southern regions.

(7) The National Center for Research on Earthquake Engineering (NCREE) performed an earthquake resistance experiment involving a bridge structure and geotechnical foundation for the first time, and conducted long-term seismic reinforcing of school buildings nationwide. These and other major R&D results have attracted favorable attention in Taiwan and abroad.

In addition, NARL has also achieved considerable synergy between services and manpower training. For instance, it has performed chip design for academic researchers in 2,238 cases, provided training to semiconductor technology manpower 6,500 person-times, provided 164,116 high-quality specific pathogen free (SPF) laboratory experimental animals, completed on-site survey work at over 3,000 schools, and recorded basic earthquake resistance information for close to 14,000 school buildings. NARL has further employed the CONsortium on Core Electronic Resources in Taiwan (CONCERT) to provide Nationwide Document Delivery Service (NDDS) to 430 library units nationwide.

**2. Strengthening inter-center cooperation; instituting performance management**

In order to make proper use of existing capabilities and reap synergy from integration, NARL continued to implement five major joint research projects in the areas of the environment and disaster mitigation, nanometer electronics and system technology, science and technology information, space technology, and biotech experimental resources. In the field of management, NARL has established an inter-center researcher hiring system and evaluation regulations, and promotes interchange personnel with different areas of expertise in order to facilitate the successful implementation of inter-center cooperative research projects.

Very importantly, NARL has established and strengthened various control mechanisms, standardized evaluations, and instituted performance management and control tasks in order to effectively boost synergy throughout all units. For instance, NARL has strengthened its control of projects, budgets, and procurement work, and implemented an audit system in order to strengthen internal control and ensure that all systems are implemented in an effective manner.

**3. Integrated project strategies and benefits**

All research projects implemented by NARL are connected with important national scientific and technological policies, and will have a major influence on the current overall development of science and technology in Taiwan. NARL strives to plan and implement scientific and technological research projects employing the different centers' core technologies and capabilities, and addressing the future needs domestic technology development and society. NARL has planned and implemented 13 branch projects in line with the characteristics of its subordinate research centers in order to strengthen the core capabilities and degree of resource integration of its experimental research units, and achieve synergy between its various centers. The branch (inter-center integration projects) projects implemented in 2010 addressed strong earthquake real-time warning system promotion research, an interdisciplinary bridge safety monitoring R&D platform, the development of an Earth observation near-real-time high-resolution three-dimensional environmental application platform, remote sensing payload technology R&D, and a biomedical electronic R&D platform. The following inter-center integrated projects that are currently being implemented:

(1) Integrated project on promotion of a strong earthquake real-time warning system: Jointly implemented by the Center for Disaster Reduction, NCREE, and NCHPC.
(2) Integrated project on a bridge safety monitoring R&D platform: Jointly implemented by the Center for Disaster Reduction, NCREE, and Typhoon and Flood Research Institute.
(3) Integrated project on development of an environmental observation high-resolution three-dimensional display platform: Jointly implemented by NCHPC, National Space Organization, ITRC, Typhoon and Flood Research Institute, NCREE, and Center for Disaster Reduction.
(4) Integrated project on remote sensing payload technology R&D: Jointly implemented by the National Space Organization and ITRC.
(5) Integrated project on a biomedical electronic R&D platform: Jointly implemented by the Chip Implementation Center, National Nano Device Laboratories, ITRC, and NCHPC.

NARL's experimental research units had the following missions and results in 2010:

**1. National Nano Device Laboratories**

Since it was founded in 1988, the National Nano Device Laboratories (NDL) has striven to support domestic academic research on the development of advanced semiconductor process technologies and also train manpower needed by the semiconductor industry. In order to support the country's technology policy and industrial development, as semiconductor process technology evolves from the submicron to the nanometer scale, NDL has spent the last few years providing services needed by industry, academia, and the research community in connection with the development of forward-looking CMOS (complementary metal-oxide semiconductor, CMOS) elements, energy optoelectronics, and biomedical MEMS on the basis of conventional silicon nanometer wafer process technology.

NDL received funding of NT$500 million in 2010 and had a staff of 165 persons, including 32 research personnel (19%). NDL implemented 109 joint research projects with academic partners, and users employed NDL's resources to complete 612 papers. In addition, NDL's user service system completed expansion of its process and equipment service modules. As of the end of December 2010, a total of 1,527 professors and graduate students had used NDL's core facilities in relevant research. Instruments and equipment were provided to external users a total of 166,902 hours throughout the year, and service income of NT$675 million was up by 4.5%. NDL also held advanced semiconductor and nanotechnology training classes 5,838 person-times. The following were some of NDL's results in 2010:

(1) Increasing memory capacity by a factor of 20, reducing power consumption by a factor of 200－9 nm ultra energy-efficient memory

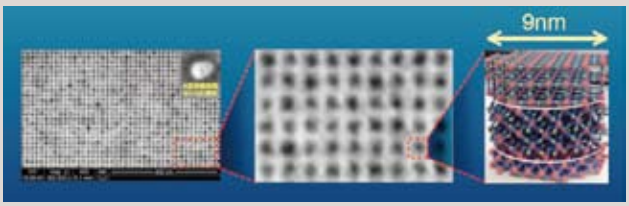
NDL developed the world's first and smallest 9 nm functional resistive random-access memory (R-RAM) array cells, which offer a capacity approximately 20 times greater than that of existing flash memory and power consumption roughly 200 times less. This new memory can store text data equivalent to an entire library in an area of only 1 cm2 with almost no energy consumption. Furthermore, this memory can be stacked in three dimensions to further increase its capacity, enabling the realization of boundless new light, thin, compact products. The findings of this research campaign were formally presented at the prestigious International Electron Devices Meeting (IEDM) held in San Francisco. The announcement of these results attracted the keen attention of international microelectronic firms, academic institutions, and research organizations, and was selected by IEDM—the world's leading conference in its field—as one of the key papers at the event. The paper concerning these findings has been listed by IEEE and the Low Power Engineering Community as an important report.

(2) A breakthrough in photovoltaic battery technology－A transistor integrated photovoltaic battery module

A research project achieved the first-ever development of low-temperature 140oC transistor integrated photovoltaic battery technology; the single-interface amorphous silicon film photovoltaic battery developed in this project achieves a world-class efficiency of greater than 9.6% and can be integrated in film transistor modules. The project's groundbreaking R&D results will be highly beneficial to green energy applications such as self-supplying power electronics circuits and multifunctional display panels. These results were announced at the 2010 IEDM. The paper describing the project's findings is currently the only paper from Taiwan on the topic of silicon film photovoltaic batteries, and was the only paper on this subject presented at IEDM.

(3) Providing one-stop services to academic and research organizations

NDL provides the only one-stop open experimental research environment in Taiwan, and ensures that domestic industry, academia, and research organizations can use this common R&D platform to share research results and technologies in different areas via various collaborative project models. NDL continued to implement academic research projects in 2010, and encouraged relevant university departments to participate in joint research work with NDL, focus specialized manpower, instruments, and equipment on promising fields, and develop nanometer CMOS element, nanometer energy, optoelectronics element, and nanometer biomedical MEMS technologies. Apart from sharing resources and shortening the process development time,




**Nanometer resistive memory (R-RAM): Innovative technology enabling the manipulation of oxygen atoms' short-distance movements achieves greater storage capacity in this memory. This technology can dramatically simplify process steps, reduce cost, and produce memory elements with dimensions of several nanometers, while greatly reducing power consumption. The technology has overcome the 10 nm technological barrier, and therefore represents a great breakthrough in nanometer element technology. It is expected that the technology will be used in mass production within the next five to ten years, and will make a major contribution to the NT$1 trillion global memory market when the time comes.**

this path forward will also enhance research efficiency, while training research manpower. A total of 109 academic research projects are currently underway, and collaborators consist of 101 professors at 36 public and private universities, including National Taiwan University, National Tsinghua University, National Chiao Tung University, National Cheng Kung University, National Central University, National Sun Yat-sen University, and National Chungshing University.

(4) Improving performance through e-services

In order to maintain service quality and the external service system, NDL has adopted a manufacturing execution system

(MES) and many online control system modules. Apart from enhancing the convenience of existing services, NDL has developed wide-ranging new functions improving the hardware and software research environment and simplify administrative procedures for internal users, while providing convenient online services to external users. NDL's MES can provide remote operating services, and can effectively manage and track the status of work in progress. Remote users can monitor production progress, increasing the convenience of outsourced projects, boosting NDL's element fabrication capacity and efficiency, and reducing production cost and risk. A total of 4,686 application forms have been approved and implemented thus far. Furthermore, NDL has completed integration of the equipment Web control system with MES data traffic, enabling element fabrication plant users to employ the MES to set experimental parameters and control switch entry/exit tasks, and facilitating integrated process services. To effectively manage information risks and maintain the security of information assets needed for the server center's continuous operation, NDL has deployed a security system and network environment, and enhanced laboratory information security management technology and capabilities. As a consequence, NDL's server center was able to obtain ISO 27001 information security system certification on September 27, 2008, and it passed re-certification on August 30, 2010.

(5) International cooperation and extension

NDL signed one cooperation extension contract and two new international cooperation contracts with prominent research organizations in 2010: A cooperation agreement with the Center for Interdisciplinary Research (CFIR) at Japan's Tohoku University called for joint nanometer CMOS element process research; a cooperation memorandum with the University of Texas called for joint research on the fabrication of high-mobility MOSFETs with EOT in the sub-nanometer region; and an extension of a cooperation agreement with France's Federation MicroNano Technologies (FMNT) and National Center for Scientific Research (CNRS) continued joint research in the areas of photovoltaic battery technology and systems, biomedical MEMs process, and nanometer CMOS elements.

NDL cooperated with America's DSG Technologies, Inc. to publish the paper "Nanoscale p-MOS Thin-film Transistor with TiN Gate Electrode Fabricated by Low-temperature Microwave Dopant Activation" in the IEEE's EDL.

**2. National Laboratory Animal Center**

Since it was founded in 1994, the National Laboratory Animal Center (NLAC) has chiefly supplied specific pathogen free (SPF) laboratory rodents to academic and biotech industry users, including universities, hospitals, research organizations, and biotech firms for use in biomedical research. In 2003, responding to international and domestic trends, NLAC made the shift from being an laboratory animal supply unit to being a full-functioned "national-level laboratory animal resource center," and in that role has continued to supply laboratory animals, provide technical services, and implement manpower training and technology R&D as a subordinate unit of the National Research Institutes. This year NLAC's facilities in northern and southern Taiwan received full accreditation from the Association for Assessment and Accreditation of Laboratory Animal Care International (AAALAC) in 2010, and won the Enterprises Team Award in the 12th Science and Technology Management Awards, showing that NLAC is a national-level experimental unit with solid software management and hardware facilities.

NLAC continued to provide high-quality, SPF laboratory animals, and including ten mouse strains, six rat strains, one guinea pig strain, and one hamster strain. A total of 164,116 rodents were sold during 2010. Services were provided to 978 research personnel at 118 research units, including universities, hospitals, research organizations, and biotech firms, during this year. NLAC received NT$309 million in funding in 2010, and employed 131 persons, of whom approximately 84% were researchers or technicians.

NLAC continued to provide rodent freezing and reproduction services, and the opening of the Rodent Model Resource Center (RMRC) in 2009 has enabled the integration of relevant technologies and laboratory animal resources. During 2010, NLAC completed germ plasm sharing for 126 strains (including import/export and consignment services), 147 commissioned mouse embryo freezing cases at its northern and southern facilities, 31 frozen preservation cases in sharing cases, and 53 purification and restoration cases. In October 2010, RMRC was registered as the 19th facility of its kind in the world and third in Asia, enhancing the international competitiveness of Taiwan's biomedical industry. RMRC currently provides information on 52 strains of laboratory animals. In its role of guardian of the health of laboratory animals in Taiwan, NLAC provided animal quality control services, including parasite, bacteria, serum, and genetic testing, 25,675 times in 2010.

The "Animal Hotel" established by NLAC in southern Taiwan raised 99 strains of laboratory animals on behalf of researchers, and provided commissioned animal care services a total of 11,230 cage-times.

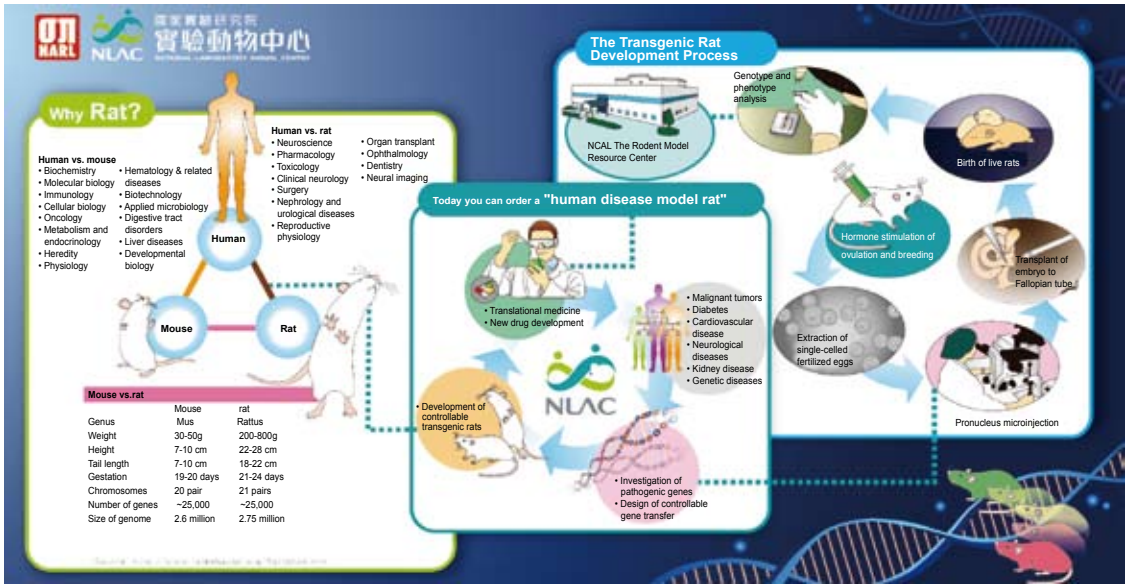
NLAC has made the following contributions to technology R&D:

(1) NLAC created the world's first controllable transgenic rat technology platform, and used this technology platform to develop a transgenic rat with controllable red and green fluorescent protein genes. This technology can be applied in the future to the production of animal models for many types of human diseases; by precisely controlling the time of disease occurrence, it will be possible to perform non-invasive observations and thereby reduce animal use.

(2) In research on the creation of a mouse animal model for polycystic kidney disease, the RNA interference method was used to develop a mouse animal model with a disease progression extremely similar to that in humans. In the future, this animal model can be used to investigate the pathogenic mechanism of this disease and search for feasible therapeutic methods. The findings of this research were published in *The Journal of Pathology*, which has the highest impact coefficient of any pathology journal in the world, and an article on the results was chosen as the cover story in November 2010.

(3) NLAC developed a known bacterial flora animal model platform, and tested mice in a monobacterial environment to determine their immune response to bacteria. Inoculated animal models can be used in the future to investigate the interactions between different source bacteria and their hosts.

(4) Microsatellite markers were used to establish whole-genome genotyping technology distinguishing C57BL/6 and 129 animal substrains, and develop a fast homologous inbred strain mouse production platform providing domestic users with fast production of high-quality homologous inbred strain mice.




**NLAC created the world's first controllable transgenic rat technology platform, and used this technology platform to develop a transgenic rat with controllable red and green fluorescent protein genes. This technology can be applied in the future to the production of animal models for many types of human diseases; by precisely controlling the time of disease occurrence, it will be possible to perform non-invasive observations and thereby reduce animal use.**

(5) NLAC successfully developed molecular biology diagnostic techniques for *Corynebacterium bovis* and *Entamoeba muris*.

(6) NLAC established a three-dimensional digital image analysis platform that can be used to analyze pathological structures in the brains of mouse models of Alzheimer's disease.

### 3. National Center for Research on Earthquake Engineering

The National Center for Research on Earthquake Engineering (NCREE) was established in 1990, and has a chief mission of planning, integrating, promoting, and implementing earthquake engineering work, developing new seismic resistance design, assessment, and reinforcing techniques, improving earthquake damage assessment and modeling methods, and performing engineering education extension. NCREE received funding of NT$267 million in 2010, and employed a total of 102 persons, of whom 61.7% were research personnel. The following were among the most significant results of the year:

Establishment of an outstanding experimental research environment, improvement of experimental and modeling technology: NCREE completed expansion of its laboratory hydraulic system, enabling better experimental service performance. In order to meet the needs of domestic earthquake engineering experiments, NCREE provided vibrating platform services 44 times, reaction wall services 35 times, MATS experiment services 12 times, and 500-ton universal materials testing device services eight times. NCREE required the dynamic displacement measurement software ImPro and planar strain measurement software ImPro Strain, and developed a new image measurement technique that can perform experimental measurements in a faster and safer manner.

Confirmation of the earthquake resistance of newly-built structures; development of performance-oriented earthquake resistance design techniques: NCREE complete draft design seismic parameters for the Kinmen area, which will be submitted to the Construction and Planning Administration, MOI for review. NCREE helped the Taiwan Area National Expressway Engineering Bureau, MOTC to complete drafting of localized bridge seismic resistance performance design standards; these standards can be used in the future as the basis for the development of a highway bridge seismic resistance design code.

Improvement of the earthquake resistance of existing structures, development of earthquake resistance diagnosis and reinforcing technique: NCREE helped the MOE to draft and revise detailed assessment operating standards, design operating standards, and construction oversight operating standards ensuring the seismic resistance assessment and effective reinforcing of high school, vocational high school, junior high school, and elementary school building structures. An interdisciplinary project involving 10 professors from National Taiwan University, National Chiao Tung University, National Central University, National Taipei University of Technology, and National Yunlin University of Science and Technology completed an on-site earthquake resistance experiment at Niudou Bridge in Yilan County. This was the first on-site bridge experiment of its kind in the world, and sought to gain an understanding of the bridge's earthquake resistance and review existing bridge seismic resistance design laws and regulations. In this experiment, a model bridge constructed at the site was subjected to impacts and erosion from floods and debris flow simulated by a hydraulic testing platform. In addition, a vibrating platform experimental system will be used to simulate interaction between soil and the bridge structure after the foundation is exposed, allowing further experiments after the completion of this integrated project.

Development of structural systems with superior earthquake resistance and advanced earthquake-resistance technologies: NCREE completed a simple equipment assessment and preliminary design checklist enabling quick seismic resistance assessment of independent equipment at technology firms and hospitals. Researchers completed a special steel concentrically braced frame member experiment to determine the seismic behavior of inward- and outward-facing buckling concentrically

**The earthquake resistance experiment at Niudou Bridge in Yilan County is the first on-site bridge experiment of its kind in the world; the experiment seeks to gain an understanding of the bridge's earthquake resistance and review existing bridge seismic resistance design laws and regulations.**

braced frame systems. The results of this research can be used as a basis for the development of seismic resistance design procedures for concentrically braced structures employing special steel members. An experiment on the mechanical behavior of ultra-high-strength reinforced concrete columns under high axial pressure led to the development of ultra-high-strength reinforced concrete techniques. A mobile wireless sensing system developed at NCREE can be applied to on-site microseismic measurements.

Strengthening of geotechnical earthquake engineering research, implementation of structural foundation earthquake-resistance design technologies: NCREE drafted vulnerability analysis procedures and methods for gravity, sheet pile, and trestle wharves at harbors in Taiwan, and also developed an earthquake damage assessment modules for harbors in conjunction with the Taiwan Earthquake Loss Assessment System; this modules can enable harbor management units to draft earthquake damage mitigation strategies. In conjunction with the Niudou Bridge on-site experiment, NCREE completed caisson displacement measurements for a caisson lateral force and bridge piling lateral force experiments. This work enabled the force-deformation behavior of a caisson foundation to be determined.

Development of earthquake damage assessment technologies in response to disaster response and risk management needs: NCREE completed scenario modeling of potentially dangerous earthquakes in the Taipei and Lanyang water-supply areas; this project identified situations in which the tap water supply rate would decrease in the wake of an earthquake, and provided earthquake response planning guidance to business units. NCREE collected data on Taiwan's highway network and compiled a comprehensive highway system database; this project can enable bridge earthquake damage assessment results to be applied to post-earthquake service performance analysis of the highway network. An earthquake status data uploading and management system can provide earthquake survey personnel with a platform for uploading earthquake damage data to the Internet. Newly-developed earthquake survey software for PC and PDA will provide earthquake survey personnel with a tool for making quick offline records of damage in affected areas, and such records can be subsequently uploading to the earthquake damage status system.

Strengthening integration of earthquake engineering and seismology, promoting application of earthquake research results: NCREE drafted a near-fault adjustment factor table for near-fault areas at different distances from class 1 active faults. This table can provide guidance to various parties and be used to improve existing building standards. NCREE personnel completed 5,527 microseismic double-difference re-location operations and 412 microseismic focal mechanism solutions, enabling the assessment of the activity and focal parameters of numerous faults. NCREE completed on-site surveys of 21 monitoring stations, and performed geological drilling surveys and suspension seismic velocity well surveys at 19 stations.

Enhancing promotion and sharing of earthquake engineering research results, implementing R&D results: NCREE invited 31 prominent international experts and specialists from ten countries to give presentations at the International Workshop on Infrastructure Systems for Nuclear Energy, which promoted the development of Taiwan's nuclear energy infrastructure. NCREE held the 2010 Seismic Design Competition, international structural earthquake resistance design training classes, seminars, lectures, and science education activities 54 times; 4,236 persons participated in these events. In addition, NCREE received seven domestic invention patents, and licensed technologies to companies in eight cases.

Development of a real-time strong earthquake warning system, utilization of real-time early warnings to lessen earthquake losses: NCREE established a full-scale real-time strong earthquake warning system display room, completed vibrating platform system testing, and developed an automatic earthquake detection and disaster mitigation control system. NCREE completed installation of real-time strong earthquake warning system demonstration stations at Fang Ho Junior High School and Yilan Elementary School; apart from performing long-term on-site system testing, NCREE is also creating awareness of earthquake preparedness among students and teachers in conjunction with earthquake workshops and disaster mitigation exercises.

Establishing interdisciplinary research platforms, developing bridge safety monitoring technology in response to different natural disasters: NCREE installed a bridge erosion hydraulic modeling experimental platform at the Hydrotech Research Institute, Water Resources Agency, MOEA to enable researchers from various universities to perform relevant experiments. NCREE developed an integrated bridge safety monitoring software platform capable of diagnosing the structural soundness of bridges subject to dynamic erosion.

Looking ahead to the future, NCREE will continue to meet the country's preparedness, earthquake response, and post-earthquake reconstruction needs by employing its experimental facilities, technology, and databases to integrate the country's relevant research manpower, strengthen international cooperation, and mitigate damage due to earthquakes.

**4. National Space Organization**

The 15-year second phase of the Long-term National Space Technology Development Plan (2004-2018) is building on the results of the first stage, and has the goal of establishing an autonomous space technology capability, and using satellite technology and scientific data from space to meet citizens' needs. In particular, FORMOSAT-5 program calls for development of an optical remote sensing satellite using domestic technology; this satellite will provide surface resolution of 2 m for black-and-white images and 4 m for color images. The remote sensing payload on

this satellite will be the first of its kind developed autonomously by a domestic team, and will pass on Taiwan's remote sensing satellite design capabilities. The National Space Organization (NSO) received funding of NT$1.2 billion in 2010, and had 190 staff members, of which over 80% were involved in research, engineering, and technology. The following were among the main results of the year:

(1) FORMOSAT-5 project－Autonomous technology development

The FORMOSAT-5 project has completed the autonomous development of technology for the satellite bus subsystem, and has also completed first- and second-stage testing and verification of the satellite engineering development module. Among autonomously developed elements, the command and data management units have been completed, and a prototype power control and distribution unit has been developed; the flight software has been developed to version 3.1, and includes power control and command/communications functions.

(2) Suborbital project－Successful launch of a sounding rocket

The data obtained from the successful May 5 Sounding Rocket 7(SR-7) mission will enable a clear understanding of the effect of changes in the high-altitude ionosphere on communications quality. In the preliminary commissioned Sounding Rock 11(SR-11) hybrid rocket Advanced Technology R&D project, a team consisting of researchers from National Chiao Tung University and National Cheng Kung University has successfully completed first-stage firing tests. The results of this project were presented at hydrodynamics and rocket propulsion seminars in Japan and India, where they impressed experts and scholars, and were also published in international scientific periodicals.

(3) FORMOSAT-2 project－Use of remote sensing images in disaster mitigation and relief

When this year's Jiaxian earthquake, Gaomei wetlands oil spill, and work safety incidents at Formosa Plastics' Mailiao Sixth Naphtha Cracker occurred, the NSO immediately transmitted FORMOSAT-2 images to relevant agencies in order to support disaster mitigation and relief decision-making and relevant actions. The many international incidents and flash points imaged by this satellite included the Gulf of Mexico oil spill, Chilean earthquake, Fujian flooding, Guizhou mudslides, and the contested Yeonpyeong Island near the Korean Peninsula. The NSO's willingness to share its images has exemplified Taiwan's major contributions to the welfare of international society.

With regard to the promotion of FORMOSAT-2 satellite images, the NSO has teamed up with the United Nations Operational Satellite Applications Programme (UNOSAT) and International Charter to provide satellite resources for use in global disaster relief and environmental survey work. Furthermore, the NSO is a member of the "Sentinel Asia" international remote sensing satellite cooperation organization, and can provide image resources in either direction when a disaster occurs. These sharing efforts will enhance Taiwan's international contributions and recognition.

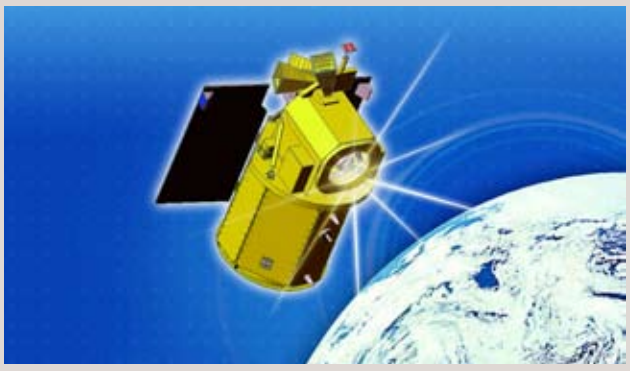
(4) FORMOSAT-3 project－Improving global forecasting accuracy

The NSO's GPS Science and Application Research Center provides an average of one million data items to users each month via its real-time and follow-up data services. Thus far, more than 1,400 persons from 54 countries have registered online to receive scientific data from the FORMOSAT-3 satellite constellation. The Central Weather Bureau's forecasting system uses FORMOSAT-3 occultation data concurrently with international users. After the Bureau inputs data to its numerical weather forecasting system, the results of analysis can verify the FORMOSAT-3's occultation data, enhancing the quality of weather forecasts.

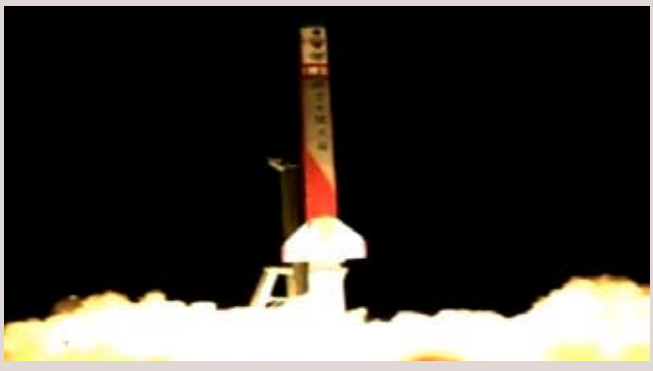
(5) Development of key technologies; international seminars

The successfully-completed structural modification and testing of the FORMOSAT-2 satellite's reaction wheel was conducted entirely using the NSO's autonomous R&D capabilities. This milestone work can be applied in the future to extending the operating life of the FORMOSAT-2 mission. The operating team's work "FORMOSAT-2 life extension and operating technology improvement" won the 4th National Applied Research Laboratories Outstanding Technological Contribution Award for its excellence in the technology development category and also received the National Applied Research Laboratories' recommendation to participate in the Executive Yuan Outstanding Contribution in Science and Technology Award.

The NSO hosted the 6th International Workshop on Satellite Constellation and Formation Flying (IWSCFF 2010); the over 100 participants at this event hailed from 16 countries and included students and representatives of domestic and foreign firms, academic institutions, and research organizations. The workshop successfully enhanced the international prestige of the FORMOSAT-3 and FORMOSAT-7 satellite constellation



**The FORMOSAT-5 project has completed the autonomous development of technology for the satellite bus subsystem.**



**The Sounding Rocket 7(SR-7) sounding rocket was successfully launched from the Jiupeng launch site in Pingtung County at 7:50 a.m. on May 5, 2010. The rocket was launched toward the east with an angle of elevation of 83° 3', and will investigate ionospheric irregularities and their causative mechanism.**

missions; expert seminars at the workshop established domestic satellite constellation and formation flying research teams, while also developing foreign liaison channels ensuring that research standards remain at the international level.

The NSO is the country's space policy implementation organization, and has the dual mission of implementing major satellite programs and boosting Taiwan's space technology capabilities. The NSO is using its internal manpower and resources to conduct relevant technology R&D and strengthen collaboration with domestic and foreign universities, research organizations, and firms in order to attain its planned objectives.

**5. National Center for High-Performance Computing**

The National Center for High-Performance Computing (NCHC) is Taiwan's sole open national-level high-speed computing and network facility. Its mission is to integrate various areas of information, science, and engineering, and provide computing, network, storage services. NCHC received funding of NT$850 million in 2009, and had a staff of 217 persons, of whom 77% were research personnel or technicians. The following results were achieved during the year:

(1) Integrating the high-performance computing environment－Creating a superior R&D infrastructure

NCHC's high-performance computing resources were used to provide services to 800 research projects, and NCHC users published 735 papers concerning these projects. With regard to the Taiwan Advanced Research & Education Network (TWAREN), NCHC added links to five schools employing the IPv4 Internet protocol, and the TWAREN backbone network maintained a service availability rate of 99.993%. In the area of international research network services, NCHC added links to three more research networks: Europe's NORDUNet, America's Microsoft, and New Zealand's KAREN.

(2) Publicizing Taiwan's high-performance computing capabilities－Outstanding R&D results

Developed at NCHC, the TWMAN malicious program analysis platform can enhance information service and analytical efficiency. The search engine Crawlzilla, which employs the cloud concept, was awarded first place in the professional section of the "Freeware Innovative Application Development Awards." NCHC completed deployment of the Formosa 3 cloud computing cluster, along with performance testing and debugging. Performance results were higher than the corresponding international standards, and overall attainment was 88%. Research on renewable energy and mesoscopic physical chemistry employing high-performance computing resources received the National Applied Research Laboratories Outstanding Technological Contribution Award. NCHC assisted and support a team led by Prof. Chung Yeh-ching of National Tsinghua University that won the world championship in the Student Cluster Competition.

**6. Chip Implementation Center**

The primary mission of the National Chip Implementation Center (CIC) is to integrate and develop a chip system design and research environment, provide chip system design realization and testing services, share chip system design technology, and promote the use of R&D results. CIC received NT$268 million in funding in 2010, and had a staff of 116 persons, of whom 76 (66.1%) were researchers. This year's major achievements included:

(1) Integration and development of the chip system design and research environment

Responding to academic research and industrial development needs, CIC assists domestic academic researchers to perform chip- and system-related research. Over the years, CIC has acquired many design and verification programs widely used in industry. During 2010, CIC provided design and verification software from 19 prominent international companies, and also freely provided seven chip and system design process environments, including electronic system level (ESL), cell-based IC, platform-based SoC, full-custom IC, FPGA, mixed-signal IC, and IC testing environments, for use by students and teachers at various schools. CIC also offered relevant technological consulting.

In the area of chip system design and verification environment and platform technology, during 2010 CIC proposed a three-dimensional heterogeneous integrated system platform—MorPack (morphing package)—which employs packaging integration technology and a platform system design concept. Thanks to appropriate system division methods and the use of a tri-state interface to implement bare die signal connections, the MorPack system offers outstanding system peripheral expandibility and flexible bare die upgrading to meet user needs at extreme low cost. Packaging integration technology and a three-dimensional stacked architecture give the MorPack system the characteristics of heterogeneous chip integration ability and miniaturization. CIC's proposed MorPack system design processes will include system-level architecture design, logic-level design, prototype verification, realization design, chip measurement and verification, and chip/substrate assembly. In the future the MorPack system platform can be used by academic researchers in research on heterogeneous integrated system hardware and software.

(2) Providing chip system design realization and testing services

CIC continued to provide chip fabrication service and establish new process design environments. With regard to chip fabrication service, CIC has 11 processes and provides real-time data updating, verification, and explanation services, including for CMOS, BioCMOS, GaAs, CMOS MEMS, CMOS BioMEMS, and high-voltage processes. CIC helped academic researchers to publish 729 papers and patent specifications, provided 2,447 instances of chip design and application services, and fabricated 1,718 chips, including 1,421 forward-looking chips. Each chip


**A team affiliated with the National Center for High-Performance Computing, National Tsinghua University, and Acer team won the world championship in the Student Cluster Competition. Shown here are Acer Vice President Chang Shan-cheng, Prof. Chung Yeh-ching of National Tsinghua University, President Chen Li-chun of National Tsinghua University, President Chen Wen-hua of the National Applied Research Laboratories, Manager Chiang Kuo-ning of the National Center for High-Performance Computing (from the left in the front row), and the National Tsinghua University SCC champion team (back row).**

resulted in an average of 0.4 papers, which is an exceptional result. Because forward-looking processes are extremely costly, CIC has developed and required sensing, biomedical, green energy, and system packaging platform technologies in order to enhance the application value of mature processes. CIC is striving to achieve the greatest possible results with its limited funding, and has induced a group of professors to participate in interdisciplinary integration, which will make a major contribution to future industrial development and manpower training.

In chip realization environment and platform technology, in conjunction with the development of high frequency applications of forward-looking CMOS, during 2010 CIC successfully used forward-looking CMOS process technology to develop millimeter wave passive circuit design technology. This technology involves the use of a CMOS MEMS process and an acid etched metal sacrifice layer to fabricate MEMs logic gate sensor structures. CIC employed CMOS BioMEMS to develop immunoassay sensors, which are a milestone in the growing application of CMOS technology in biomedical applications. Many research results achieved at CIC are issued at major international conferences or published in important academic journals. In the area of system packaging and module technology development, CIC notably completed deployment and testing of a CMOS/IPD schematic-driven cooperative design process, and linked this process with the IPD DRC process, and also issued a preliminary technical report concerning integration of DRC/LVS verification processes.

(3) Chip system design technology sharing and results extension

CIC offers IC design training classes and online classes to train chip and system design manpower. CIC offered 175 sessions of 58 types of training classes in seven design method categories in 2010 (including three new classes). Most lecturers consisted of CIC engineers; approximately 6,046 students and instructors from various schools attended the classes. To encourage student and instructor teams to engage in IC design research, and enhance the design skills of students and instructors, CIC also held the "University Integrated Circuit Design Contest" (under commission to the MOE), the "ARM Code-O-Rama Design Competition," and a chip fabrication results announcement conference. CIC hopes to encourage outstanding chip production projects and design, and achieve its goals of promoting forward-looking chip system design technologies and training superior chip system design manpower.

**7. Instrument Technology Research Center**

A country's technological development and autonomy depend on the presence of an effective instrument technology R&D environment. The Instrument Technology Research Center (ITRC) was created through reorganization in June 2003, and adopted the role of "establishing instrument technology service platforms and developing forward-looking and novel instrument technologies" in 2009. During 2010, ITRC focused on the development of "intelligent, graphic instrument control technologies" and "instrument system integration technologies," and also developed a space remote sensing optical payload and green, biomedical, and miniaturized instruments in conjunction with national policies.

ITRC received funding of NT$340 million in 2010. Its staff numbered 155 persons, of whom 131 persons were research personnel or technicians (84.5%). In order to provide even more professional, friendlier, and better service, despite its limited resources, ITRC actively maintained the ISO 9001 quality management system, ISO27001 information security management system, and Taiwan Accreditation Foundation certification as complying with the ISO 17025 quality system. In the future, ITRC is committed to establishing service platforms meeting the needs of academic and research organizations, and assisting universities and research units to transform forward-looking research results into applied technologies that can enhance citizens' welfare.

In keeping with its primary focus on instrument technology, in order to improve instrument innovation and industrial technology, ITRC developed around a dozen major instrument systems in 2010, including a near-field optical microscope light collection system, a multiple-plate single-trough photocatalytic reactor, an electrochemical real-time quantitative monitoring magnifying instrument, a high sensitivity infectious disease testing instrument system, a helical vacuum pump testing system, a non-contact micro-displacement measurement system, and a metal atomic layer deposition system. All of these instruments have industrial and academic applications. In the development of key elements for industrial and academic instruments, ITRC successfully developed more than ten key elements, including an atomic layer deposition system development system mechanism and electrical control interface technology, a biomedical microsystem monitoring module, a constant-temperature electrical potential control module, a long-focal-depth diffractive optical element, and an elliptical condenser, as well as seven key software applications.

International visibility is an important indicator of a national laboratory. ITRC has established its leadership in Taiwan through long-term development of optical and vacuum technology. In order to transform ITRC into a world-class instrument technology R&D center of excellence, it is actively promoting international cooperation, and strengthening contact and interchange with the international instrument community. In the area of international cooperation, ITRC signed memoranda of cooperation with the Photonics Research Center at Britain's University of Southampton, the Optical Information Storage Center at the University of Arizona, Japan's RIKEN Advanced Science Institute, and South Korea's Center for Information Storage Device at Yonsei University. ITRC additionally engaged in joint research with such top-notch organizations as the Chinese University of Hong Kong and the MEMs research center at Singapore's Agency for Science, Technology and Research (A*STAR).

During 2010 ITRC hosted the "Forum on Taiwan's Electronic Medical Equipment Opportunities," "2010 2nd i-ONE Instrument Technology Innovation Awards," and "Seminar on Large Aperture Remote Sensing Payload Opto-Electromechanical Technology." In addition, ITRC also organized the "2010 NAMIS International Seminar," and participated in the "SPIE Photonics West 2010," Taiwan pavilion at "Japan Nano Tech 2010," "2010 Opto Taiwan," "2010 NI Week Conference," "2010 Taiwan Health," "Taipei International Industrial Automation Exhibition 2010," "SPIE Optics+Photonics 2010," "2010 Taipei International Invention Show and Technomart," "62nd Nuremberg International Invention Exhibition," "Taipei International Instruments Show," and Taiwan pavilion at the "World Graphical System Design Convention." ITRC personnel took advantage of opportunities at these events to present reports concerning relevant technologies, which actively promoted ITRC's R&D results.

In the area of high-tech manpower training, ITRC provided

**ITRC's patented high voltage signal generator with single-period and continuous waves was awarded a silver medal in the National Invention & Creation Awards**

training to 1,113 high-tech professionals. In addition, in order to promote Taiwan's science and technology diplomacy, ITRC provided training on the topic of nanometer biomedical technology to 25 R&D personnel and technology managers from India, Vietnam, Thailand, Indonesia, the Philippines, and Laos via its long-term international scientific instrument technology training program. With regard to training for domestic university students, ITRC provided training to 70 M.S. and Ph.D. students via its Graduate Student Participation in Research Projects Program to provide R&D seed personnel to meet the future needs of high-tech industry.

In order to expand its instrument manpower training, during 2010 ITRC invited outstanding domestic instrument technology experts to offer a five-day common instrument technology class providing systematic basic common instrument training and shortening cultivation time by teaching graduate students to use instruments, design experiments, and analyze data. Nearly 200 students from numerous universities attended this class, which made a significant contribution to the training of manpower able to perform basic research. Class content will be adjusted in the future to better meet needs and ensure that ITRC's instrument technology training service platform can yield even greater benefits.

In order to boost knowledge of instrument technology throughout industry, academia, and research organizations, ITRC published six issues of the journal *New Instrument Knowledge* in 2010; the content of these issues included special articles on photovoltaic batteries, energy technology, environmental change research, nanometer testing and applications, new microbial testing methods, and advanced optoelectronics technology. In addition, ITRC also updated the data in the "National Instrument in Equipment Information System," which provides technical information concerning instruments.

In the area of technical services and technology diffusion, ITRC established technical service platforms and provided industry, universities, and the research community with instrument-related technical services on 1,509 cases. Service recipients included 147 firms, 25 academic units, and ten research organizations. ITRC transferred technologies to domestic companies in six cases, which successfully achieved the ideal of transferring R&D results to the private sector for remuneration.

In commissioned and joint research, ITRC signed contracts for more than ten commissioned and joint research projects during 2010, including contracts for the projects "Design of a High-speed Truncated Optical Measurement Module" and "Design of a Long-distance Mirror Optical Module" with National Taiwan University, "Electronically-controlled Microwave Container" with National Chungshing University, "Vacuum System for Pulsed Laser Epitaxy" with National Taiwan Normal University, and "Metallic Film Atomic Layer Deposition System" with Yuan Ze University. These projects used instrument technology to help academic researchers to perform cutting-edge research.

**Awards received by ITRC in 2010**

| Competition | Participating works | Award |
|---|---|---|
| National Invention & Creation Award | High voltage signal generator with single-period and continuous waves | Silver medal, creativity category |
| Outstanding Reserve Personnel Competition, Defense Industry Reserve System | Chen Yung-hsiang, Chen Chien-hung, Lin Yu-chuan | Outstanding reserve personnel |
| 2010 62nd Nuremberg International Invention Exhibition (open section) | MTF measurement device with a single-axis complex edge algorithm, one shot bipolar waveform generating device and method, liquid lens module testing device, and invisible light emitting element output beam testing device | Four gold medals |
| 2010 Taipei International Invention Show and Technomart | MTF measurement device with a single-axis complex edge algorithm, embedded system and its data access method, eccentricity testing device for optical lens modules, original constitution material light absorption range-expanding composite material, a virtual telescopic method, and synchronous image testing device | Four gold medals, two silver medals |
| 6th Metrology Innovation Award, Chinese Metrology Society | Fast lens MTF measurement machine | Metrology R&D Innovation Award |
| 2010 Cross-strait Forum on Co-operation and Development of Traditional Chinese Medicine | Development of High-throughput Screening Assays for the Evaluation of Skin Whitening Agent by CMOS Photoransistor, Development of Aptamer-based Biosensors for Tumor Marker Recognition in Chinese Medicine | Two bronze medals |
| Chinese Association for Chemical Sensors in Taiwan | Use of an extended gate field effect transistor biosensor to measure DNA nanometer template synthesis in real time | Best Paper Award |
| 14th Nano and Microsystem Technology Conference | Application of catalyst etching technology to silicon nanorod array fabrication | Best Paper Award, nanotechnology category |
| 7th Asian-Australasian Conference on Composite Materials | Programmed Self-Organization of Nanoparticles on a DNA-Templated Nanostructure | Best Student Poster Award |

### 8. Science & Technology Policy Research and Information Center

The chief mission of the Science & Technology Policy Research and Information Center (STPI) is to support academic research and the government's scientific and technological policy decision-making. STPI's work during 2010 emphasized the five core areas of improvement of technological foresight and capability analysis, innovation systems and national competitiveness, performance assessment, science and technology project management, and technical information integration services. STPI also strengthened the integration of core capabilities and results and development of applications, provided decision-making information to the NSC and other agencies with S&T-related responsibilities, performed numerous services connected with scientific research management, and provided the Consortium on Core Electronic Research in Taiwan (CONCERT) and Nationwide Document Delivery Service (NDDS) to academic research personnel nationwide.

During 2010, STPI implemented NT$232 million of its budget of NT$236 million, for an implementation rate of 98.07%. STPI's staff of approximately 120 included S&T policy research personnel (31%) and information services personnel (40%). STPI provided information to agencies with S&T-related responsibilities 29 times, completed ten research reports and 11 analytical reports, and supported the NSC's work 17 times. Taking improvement of the quality of government S&T projects as an example, STPI compiled teaching materials combining theoretical and practical elements, and sent personnel to give 11 presentations in an effort to help improve the quality and efficiency of the government's S&T policies. Academic research results took the form of six papers published in *SSCI*- and *SCI*-grade periodicals, as well as 29 papers published in domestic periodicals or presented at conferences, including one paper that received a Best Paper Award from the American Evaluation Association. In addition, CONCERT acquired 113 databases in 48 systems, and held information service education and training activities attended by more than 3,000 persons. NDDS provided services to academic research personnel 148,000 times; NDDS had accumulated 616,000 information items in its database, and its information service platform was used 11.3 million times.

### 9. National Science and Technology Center for Disaster Reduction

The National Science and Technology Center for Disaster Reduction (NCDR) was established in 2003 and has a primary mission encompassing the three main areas of disaster mitigation technology R&D and promotion, technical support, and application implementation. NCDR had a budget of NT$153 million and a staff of 90 persons in 2010. The center achieved the following major results during the year:

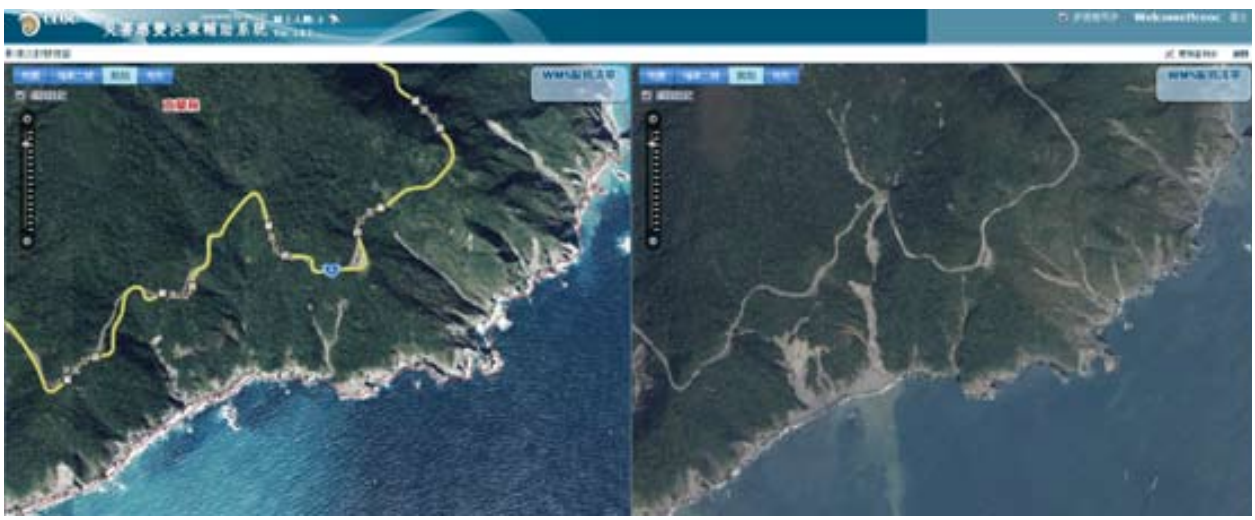
(1) Response to typhoon-induced flooding and disaster mitigation research

Development of a typhoon-induced flooding information service platform and risk assessment system: NCDR completed a national disaster monitoring and early warning platform, and deployed a disaster response decision-making assistant system enabling a response commander and staff to monitor the overall situation.

Typhoon-induced flooding data collection and value-adding analysis: NCDR completed a database concerning Typhoon Morakot and a 2001-2009 historical database concerning typhoon-induced flooding. Survey maps of disaster-prone areas in Nantou, Changhua, Yunlin, Chiayi, Tainan, Kaohsiung, and Pingtung counties were produced and provided to primary-level disaster mitigation and relief units for reference purposes. NCDR improved the efficiency of the disaster survey system, enabled the automatic compilation of survey data to a database, and used a general-purpose geographical information and analysis system to perform value-added overlay analysis.

R&D of integrated rainfall and flooding analysis technology: NCDR developed quantitative extended rainfall forecasting technology, regional rainfall analysis technology, improved flash





**Disaster mitigation and response decision-making assistance system: Comparison of remote sensing images before (right) and after (left) Typhoon Megi showing landslides along the Suao-Hualien Highway between kilometers 112 and 116.**

flooding simulations and application to real operations, and a rainfall and flooding visualization system.

(2) Earthquake response and disaster mitigation research

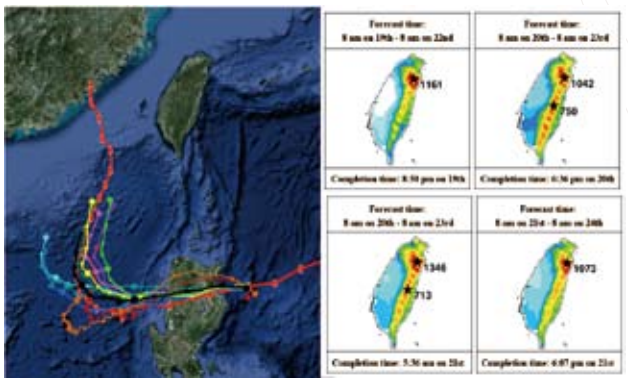
Earthquake risk analysis and response research: NCDR performed real-time earthquake information processing and value-added analysis in order to strengthen post-earthquake emergency response, and performed assessment of earthquakes that may cause landslides.

Deployment of a strong earthquake real-time warning system: NCDR completed conceptual planning of deployment mechanisms for strong earthquake real-time warning applications, and established demonstration strong earthquake real-time warning stations at the Center for Disaster Reduction and schools.

(3) Research on new issues in disaster mitigation

Development of adaptation strategies in response to climate and environmental changes: The NCDR will perform the following tasks as part of the NSC's 2010-2012 three-year "Taiwan Climate Change Forecasting and Information Platform Establishment" project: Analysis and forecasting of regional climate change, development of downscaled technologies, and analysis of the impact of extreme climate change and natural disasters. NCDR completed drafting of the "National Climate Change Adaptation Policy Framework" and "Report on Catastrophic Impacts of Climate and Environmental Changes."


**The under-construction Ocean Researcher 5 is the country's first large (2,700 ton class) research vessel**



**Results of quantitative rainfall numerical modeling ensemble forecasting experiment for Typhoon Megi. The red line in the left image is the actual path of the typhoon, and the black line is the ensemble path; the remaining lines are the paths predicted by other members of the ensemble. The images on the right show ensemble rainfall forecasts for successive days (units: mm).**

(4) Government policy assessment and implementation

2007 - 2010 Strengthened Disaster Mitigation and Relief Technology R&D and Implementation Operating Program: The results of this program included a basic data survey, database compilation and updating, environmental surveys of disaster-prone areas and determination of hazard potential, risk analysis, review of systems and projects, establishment of environmental monitoring technologies and systems, and enhancement of early warning performance.

Establishment and promotion of community-level disaster mitigation mechanisms: In 2010 NCDR provided 72 hours of training to 1,434 persons, including members of central and local disaster relief authorities, assisting organizations, and relevant private organizations. NCDR revised community-level disaster mitigation administration and research operating models, and developed a community-level disaster mitigation public-private cooperation model.

(5) Major natural disaster damage surveys and policy recommendations in 2010

NCDR submitted the "Preliminary Survey Report on the Freeway No. 3 3K+100 Side Slope Landslide" to the NSC, MOTC, Ministry of the Interior, National Disasters Prevention and Protection Commission, Office of Disaster Management, and other relevant agencies in May 2010.

Typhoon Fanapi caused widespread flooding in the Tainan, Kaohsiung, and Pingtung areas during September 2010. After collecting data on flooding scope and depth, landslides, damage to roads and bridges, flood prevention facilities, and damage to schools, NCDR analyzed causes of damage and submitted improvement strategies to the responsible authorities for their reference.

In October 2010, Typhoon Megi caused landslides, rockfall, debris flow, and roadbed erosion in the section of the Suao-Hualien Highway between kilometers 112 and 116, resulting in loss of life, injuries, and destruction of vehicles. NCDR invited experts and scholars to perform a point survey and assessment at kilometer 115.9, and submitted future disaster prevention recommendations for the reference of relevant units.

**10. Taiwan Ocean Research Institute**

The Taiwan Ocean Research Institute (TORI) was founded in 2008 with a primary mission of establishing R&D platforms to advance marine research; serving as the government's marine technology staff organization by monitoring marine environments and providing government with technical information supporting maritime administration; developing forward-looking marine technology and establishing solid marine technology R&D capabilities; and promoting the nation's sustainable development of the sea. TORI's current work chiefly consists of strengthening the marine research infrastructure, strengthening its internal framework, and providing marine information and services. TORI's research projects address the five major areas of long-

term marine hydrological observation and analysis in the waters around Taiwan, marine disaster prevention and relief research, maritime engineering research, marine exploration technology research, and establishment of marine information service networks. TORI had a NT$360 million budget and staff consisting of 59 persons in 2010; research personnel accounted for 58% of this total, and engineering and technical personnel accounted for 32%.

TORI has completed joint development of the first-generation "Yardbird" undersea seismometer in conjunction with the Academia Sinica and National Sun Yat-sen University. The Yardbird seismometer can effectively monitor undersea earthquakes, and several undersea tests have shown that this seismometer is highly sensitive to near earthquakes and can readily detect distant and deep earthquakes. The Yardbird was displayed at the 2010 marine science convention, geology and geophysics convention, and undersea technology symposium, and received initial affirmation from the research community.

In addition, TORI has issued the contract for construction of the nation's first large (2,700 ton displacement) research vessel, which has been formally named Ocean Researcher 5 by the NSC. Plans call for the vessel to be launched between April and June of 2011, and begin formal operation in July 2012. The vessel will be used to support basic oceanographic research in order to strengthen Taiwan's marine research capabilities, while also performing full-scale, systematic oceanographic surveys of the waters around Taiwan; marine data obtained by the vessel will be collected in a "national marine database," which will be provided for general research use and serve as an important reference supporting decision-making and the drafting of marine policies by government agencies.

**11. Taiwan Typhoon and Flood Research Institute**

The Taiwan Typhoon and Flood Research Institute (TTFRI) Preparatory Office is focusing its efforts on the improvement and deployment of a real-time atmospheric modeling and forecasting system, and development of integrated typhoon rainfall forecasting technology and watershed hydrology models for river basins with high hazard potential. When a typhoon threatens Taiwan, TTFRI submits the results of its quantitative rainfall modeling ensemble forecasting experiment in real-time to the Central Weather Bureau, MOTC; Water Resources Agency, MOEA; Taiwan Water and Soil Conservation Bureau; and National Center for Disaster Reduction for reference and application, enhancing the effectiveness of disaster mitigation and relief measures. In addition, TTFRI also employs the hydrological models of watershed areas that it has developed to perform real-time simulation of runoff in river basins with high hazard potential. Flooding potential distribution simulation results can be displayed in 3D using software developed by TTFRI in conjunction with the National Center for High-Performance Computing. Furthermore, TTFRI employs the same settings as used by the Central Weather Bureau, and obtains real-time meteorological observation data, which supports quantitative typhoon rainfall forecasting technology R&D and technology transfer by academic researchers and TTFRI, assisting the improvement of quantitative rainfall forecasting accuracy and reducing uncertainty in the typhoon and flooding decision-making support system. TTFRI is further using its observation capabilities to support academic surface water vapor flux observations and the Southwest Monsoon Experiment, and has performed analysis of the mechanism by which the southwest monsoon and terrain influence typhoon-borne torrential rains. In 2010, TTFRI had a budget of NT$60 million and a staff of 33 persons, 85% of whom constituted research and technical personnel. The following major results were achieved during the year:

(1) Academic achievements

This year 15 papers based on research done at TTFRI were published in domestic and foreign journals, 23 papers were issued at domestic and foreign symposia, and two technical reports were published. All papers issued overseas were published in periodicals collected by *Science Citation Index* (*SCI*).

To promote international academic cooperation and interchange, improve Taiwan's typhoon and flood forecasting capability, and research on relevant topics, in 2010 TTFRI held one international symposium, one domestic symposium, and two popular science education activities.

(2) Technological innovation

TTFRI's quantitative typhoon rainfall numerical modeling ensemble forecasting experiment yielded better predicted tracks for typhoons occurring during 2010 than the tracks predicted by most leading meteorological organizations in Europe, the US, and Japan. When Typhoon Megi struck Taiwan, TTFRI made the prediction that Megi would turn north after moving west into the South China Sea two days in advance of similar predictions by meteorological forecasters in other countries. Starting on the 19th, TTFRI continuously forecast that the Suao area would receive in excess of 1,000 mm of extreme torrential rain from Typhoon Megi, and provided this information in real-time to the Central Weather Bureau, Water Resources Agency, Taiwan Water and Soil Conservation Bureau, and National Center for Disaster Reduction for their reference.

(3) Support and service

In conjunction with the NSC's and Central Weather Bureau's Southwest Monsoon Experiment, TTFRI completed a three-week intensive observation experiment during Taiwan's late-spring/early-summer rainy season, and, in collaboration with academic researchers, also performed radar rainfall and land-atmosphere water flux observations during typhoon periods in the mountainous areas of the Qishan River basin, which is located in southwestern Taiwan. Apart from providing the spatial and temporal distribution of torrential rains during typhoons, these observations also shed light on surface and atmospheric water vapor and energy flux during periods of heavy rain.

# III. Manpower Recruiting and Training

## A . Recruiting of S&T Personnel

Scientific and technological personnel are the driving force behind S&T development and national progress, and all leading countries are thus competing to recruit more S&T personnel. In order to strengthen research and development at academic research organizations and universities, the NSC consequently employs generous support to attract outstanding domestic and foreign scientific and technological personnel. The NSC offered the following assistance measures in 2010:

1. Effective mechanisms for recruiting technical and scientific manpower:
   (1) Establishment of a supporting platform for manpower recruiting: The NSC has drafted various recruiting measures, provides generous support for recruiting, and helps academic research organizations to recruit overseas technical manpower for work in Taiwan. Specific measures included:
      a. Recruiting of visiting personnel and post-doctoral researchers to participate in S&T research projects, and recruiting of research scientists to implement major mid-/long-term research projects; such personnel were recruited a total of 2,755 person times throughout 2010.
      b. Recruiting of overseas senior experts and high-tech industry personnel (Elite Project): The NSC helps recruit senior experts living overseas to return to Taiwan to provide short-term consulting services. To support this work, the NSC has established regional service points, a dedicated Chinese-English web site, and a manpower supply and demand database. Senior experts living overseas were recruited 13 person-times during 2010.
      c. Implementation of the "Outstanding Scholar Award" and "Work Transition Fund for Recruiting of Overseas S&T Manpower" in order to encourage outstanding S&T personnel overseas to return to Taiwan for long-term employment. A total of 24 outstanding personnel received awards during 2010.
   (2) Building an outstanding R&D environment: The NSC is implementing national science and technology programs linked with key areas of scientific and technological development in Taiwan, and expects that the promotion of large-scale research projects will create an excellent research environment and attract overseas S&T to participate in research in Taiwan.
2. Reviewing and strengthening S&T manpower recruiting assistance measures: In conjunction with regulations concerning avoidance of the hiring of temporary personnel at agencies and schools in the *Regulations Governing the Hiring and Utilization of Temporary Personnel at Agencies and Schools Subordinate to the Executive Yuan,* certain revised articles of the *Regulations Governing the Recruitment of Visiting Science and Technology Personnel with Subsidies from the National Science Council* were announced on October 12, 2010 in order to clarify the intent of the NSC's policy of providing subsidies to recruit overseas S&T personnel willing to engage in research in Taiwan, emphasize the spirit that recruited personnel should participate in research in a full-time basis, and strengthen performance of duties by recruited personnel and management of applicant organizations. Furthermore, in order to strengthen subsidy review mechanisms, revised review operating regulations in Article 6 of the *Regulations Governing the Recruitment of Visiting Science and Technology Personnel with Subsidies from the National Science Council* were announced on December 28, 2010.
3. Promotion of the "Commissioned Research Project on the Dynamic Tracking Survey of Post-Doctoral Researchers Recruiting with Subsidies": In order to gain a better understanding of the needs of post-doctoral researchers recruiting with government subsidies with regard to the three aspects of working conditions, administration and support, and professional training, as well as determine the degree to which the experience of post-doctoral researchers benefits their research careers, the NSC developed post-doctoral researchers assessment indicators after consulting foreign organizations' post-doctoral researcher surveys and research, and proposed and implemented a post-doctoral researcher survey for Taiwan. The findings of this survey will guide the government's adjustment of post-doctoral research policies and help post-doctoral researchers' professional development.
4. Continued expansion of subsidies for the recruiting of post-doctoral researchers: In order to establish post-doctoral research mechanisms, encourage new Ph.D.-holders to participate in research during the "golden period" immediately after their graduation, and strengthen their independent research skills, the NSC continued to increase funding recruiting of post-doctoral researchers of ROC nationality in line with the increase in funding for research personnel participating in existing specific-topic research projects. A total of 1,985 post-doctoral researchers of ROC nationality were recruited throughout 2010.
5. Overseas publicization of S&T manpower recruiting: In conjunction with the Executive Yuan's overseas S&T manpower recruiting delegations, overseas recruiting activities were held under the supervision of the Executive Yuan

**NSC-funded S&T personnel recruiting statistics, 2006-2010** **Units: person times**

| Item | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|
| Lecturing professors | 25 | 39 | 41 | 53 | 47 |
| Visiting professors | 65 | 89 | 97 | 98 | 108 |
| Visiting associate professors | 14 | 21 | 18 | 32 | 35 |
| Visiting assistant professors | 7 | 13 | 15 | 18 | 31 |
| Visiting specialists | 8 | 14 | 18 | 18 | 12 |
| Post-doctoral researchers | 887 | 1,066 | 1,302 | 2,411 | 2,522 |
| **Total** | 1,006 | 1,242 | 1,491 | 2,630 | 2,755 |

Science and Technology Advisory Group; these activities were implemented by the MOEA, MOE, and NSC with the assistance of other agencies and overseas units, and were carried out in coordination with overseas Chinese groups. In September 2010, personnel were sent to San Francisco (Silicon Valley), Austin, Boston, and Toronto to hold recruiting activities aimed at inducing more overseas personnel to work in Taiwan. A total of 229 persons participated in explanatory meetings, and personnel took part in one-on-one recruiting sessions 1,409 person-times. The NSC expanded the "Golden Decade of Innovative Taiwan" activity in 2010, and set the goal of "building a powerful country through innovation. This activity publicized Taiwan's new industrial development and global recruiting policies, and announced new opportunities for investment in Taiwan in light of the Economic Cooperation Framework Agreement with China. Taiwan's well-developed information and communications technology and growing cloud computing expertise make this a good time to establish multinational research centers in Taiwan and recruit Taiwan's well-educated, internationally-savvy manpower. A total of 561 persons took part in this forum.

## B. Training of S&T Personnel

In order to enhance the qualifications and international perspectives of domestic teaching and research personnel, and acquire the newest S&T knowledge from the leading countries, the NSC provides subsidies to S&T personnel wishing to study at foreign universities or perform research at foreign research organizations. The NSC has provided such subsidies 46 times since 1960. Furthermore, responding to the recent drop in university and college students studying abroad, the NSC instituted the "Graduate Student Study Abroad Program" to provide subsidies to domestic in-school Ph.D. students wishing to participate in 7-12 month short-term research and study programs at prominent foreign universities and research organizations, and also provides grants to Taiwanese postdoctoral researchers wishing to one- to two-year research abroad.

In order to promote collaborative research between domestic academic researchers and overseas enterprises, encourage substantive interchange between research personnel, and select outstanding domestic students to receive specialized training or take part in new technology workshops at industrial organizations or applied research organizations abroad, the NSC began providing subsidies for "international industry-academic collaboration, interchange, and professional training projects" ("Flying Eagle Program") in 2007; to date this program has provided subsidies to 37 international industry-academic collaboration, interchange, and professional training projects, sponsored 102 reciprocal visits, and funded overseas industrial training by 39 promising young domestic scholars.

The NSC also drafted and began implementing the "Mission-Oriented Team Foreign Training Subsidy Program" ("Dragon Gate Program)" in 2009; this program provides subsidies to outstanding domestic individuals who receive training at designated world-class overseas public or private research organizations in key technologies urgently needed for Taiwan's future development. The program is training R&D personnel specializing in the key technological areas that will drive Taiwan's development, enhance Taiwan's autonomous R&D capacity, and promoting higher standards of domestic technological innovation. The NSC accepted applications from 24 teams (including 38 Ph.D. students and post-doctoral personnel) in 2010.

Starting in 2010, the NSC began implementing the three-year "Subsidy Program for Establishment of Top-notch Multinational Research Centers in Taiwan" on a trial basis in an effort to boost national competitiveness and strengthen academic research capacity. Furthermore, in order to help Taiwan's research universities reach the international academic summit, the NSC has adopted a "shared funding" approach in which research center funding includes funds raised by the applicant organization, funds from a foreign partner organization, and the NSC subsidies. The NSC has limited subsidies for each research center to a maximum of NT$50 million annually, where subsidies may not exceed one-third of total funding and funds from the foreign partner organization may not be less than one-third of total funding. At present three multinational research centers have been established: the Intel-NTU Connected Context Computing Center established by Intel and National Taiwan University, the International Center of Excellence for Advanced Bioengineering Research established by the University System of Taiwan and University of California, San Diego, and the Center for Dynamical Biomarkers and Translational Medicine established by National Central University and Beth Israel Deaconess Medical Center/ Harvard Medical School.

To encourage young second-generation Taiwanese overseas to visit Taiwan and learn about the country's development, eight agencies (including the NSC, Ministry of Foreign Affairs, Overseas Compatriot Affairs Commission, DOH, EPA National Youth Commission, and Academia Sinica) and NARL and Taiwan Foundation for Democracy have jointly implemented the "Taiwan Tech Trek" program. This program sponsors summer trips to Taiwan by youths of Taiwanese descent returning to Taiwan in order to participate in internships at public and private organizations and enterprises. The program creates positive publicity concerning Taiwan overseas, and will induce some participants to return to Taiwan to work. Six sessions of the Taiwan Tech Trek have been implemented from 2005 to 2010, and a total of 1,446 persons have participated.

**Manpower Training Statistics, 2006-2010** **Units: person times**

| Item | S&T personnel advanced study abroad | Graduate Student Study Abroad Program | | Taiwan Tech Trek | Flying Eagle Program |
|---|---|---|---|---|---|
| | | Ph.D. students | Post-doctoral research personnel | | |
| 2006 | 202 | 146 | 10 | 277 | - |
| 2007 | 209 | 163 | 46 | 266 | - |
| 2008 | 220 | 178 | 53 | 227 | 25 |
| 2009 | 252 | 186 | 75 | 225 | 63 |
| 2010 | 267 | 185 | 66 | 268 | 53 |
| **Total** | 1,150 | 858 | 250 | 1,263 | 141 |

# IV. Research Awards

## A. NSC Awards

### 1. Outstanding Research Award

The NSC established the Outstanding Research Award in order to encourage scientific and technological personnel with outstanding research results to engage in long-term academic or academic-industrial research, and thereby enhance the country's academic research standards and industrial technology R&D capabilities. Starting from 2010, the number of annual recipients of the Outstanding Research Award will be limited to 98 (93 academic research awards (including a maximum of 5 interdisciplinary research awards) and 5 industry-academic collaboration awards). Apart from receiving a certificate from the NSC, recipients receive an award of NT$300,000 annually for three years. Recipients may receive this award up to three times; recipients who have received the Outstanding Research Award three times may apply for specially-contracted research projects in accordance with relevant regulations. A total of 586 academic research award applications (of which 145 were interdisciplinary research applications) and 34 industry-academic collaboration award applications were received in 2010; awards were granted to 89 persons.

### 2. Ta-You Wu Memorial Award

The NSC established the Ta-You Wu Memorial Award in 2002 in order to cultivate young researchers, encourage the academic elite of tomorrow to commit themselves to long-term academic research, and honor the contributions of Ta-You Wu to the development of science and technology. The award's prize money system and number of recipients were revised in 2007 in order to enhance the award's effectiveness. Apart from receiving a medal from the NSC, award-winners receive NT$500,000 annually for up to three consecutive years for project and foreign travel expenses while implementing a specific-topic project. The number of award-winners has been increased to 35.

Furthermore, the *National Science Council, Executive Yuan Ta-You Wu Memorial Award Selection Operating Guidelines* were revised 2009 to increase the number of recipients to 40. As of January 1, 2010, the award is now granted to 40 individuals annually.

### 3. R&D result incentive measures

The NSC revised the *Guidelines for the Funding of the Management and Extension of Academic Research and Development Results* in January 2006 in order to promote the transfer and extension of academic research results. The following performance-oriented award and assistance measures in the *Guidelines* encourage academic research organizations to accelerate their establishment of research result management and extension mechanisms:

(1) Technology Transfer Incentives: These awards are given to project-implementing organizations that effectively manage and extend the results of research and development projects; the research money is divided among personnel who have demonstrated outstanding performance and contributed to the completion of technology transfer. Each technology transfer case must have generated income of at least NT$300,000. An organization may submit an application to the NSC for this award before the end of each July; the NSC shall grant award money to the best organizations after a review process. Awards were granted to 21 organizations in 2010.

**Research Awards and R&D Results Extension Grants, 2006-2010**

| Item | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|
| Outstanding Research Award (persons) | 35 | 35 | 40 | 90 | 89 |
| Outstanding Industry-academic Collaboration Award (persons) | 1 | 3 | | | |
| Ta-You Wu Memorial Award (persons) | 25 | 35 | 35 | 35 | 40 |
| Technology Transfer Incentives (cases) | 14 | 29 | 25 | 18 | 21 |
| Outstanding Technology Transfer Contribution Award (cases) | 2 | 4 | 4 | 4 | 5 |
| Outstanding Technology Transfer Center Grants (cases) | 5 | 5 | 5 | 5 | 5 |
| Executive Yuan Outstanding Contribution in Science and Technology Award (persons) | 2 | 15 | 10 | 11 | 2 |

Notes: 1. Recipients of the Outstanding Research Award and Ta-You Wu Memorial Award were selected from among the principal investigators of NSC-funded specific-topic research projects in 2004.Starting in 2006, qualified interested parties have been able to submit applications for the Outstanding Research Award, and the NSC selects recipients from among the applicants.

2. The maximum number of annual winners of the Ta-You Wu Memorial Award was increased to 35 starting in 2007 and to 40 starting in 2010.

3. The Outstanding Industry-academic Collaboration Award was combined with the Outstanding Research Award starting in 2008, and the total number of annual recipients increased to 40.

4. In 2009, the number of annual recipients of the Outstanding Research Award was limited to 93 (88 academic research awards and 5 industry-academic collaboration awards). The number of annual recipients was changed to 98 (93 academic research awards (including a maximum of 5 interdisciplinary research awards) and 5 industry-academic collaboration awards) starting in 2010.

(2) Technology Transfer Contribution Award: After selection from the list of technology transfer awards for the year, the NSC gives special recognition to research personnel and research teams that have made significant contributions to the transfer of R&D results, and grants trophies to teams and medals to team members to acknowledge their contributions. Awards were granted in five cases in 2010.

(3) Grants for superior technology transfer centers: The NSC conducts annual evaluations of universities and academic research organizations that have established dedicated technology transfer units, and grants recognition to superior and effective units in the form of medals plus NT$1-2 million grant money. Five schools won such grants in 2010.

## B. Other Awards

Executive Yuan Outstanding Contribution in Science and Technology Award

The Executive Yuan drafted the *Implementation Guidelines for Recognition of Persons Making Outstanding Contribution in Science and Technology* in order to recognize the country's outstanding scientists and engineers. Originally known as the "Outstanding Achievement in Science and Technology Award," the award was renamed the "Executive Yuan Outstanding Contribution in Science and Technology Award" in 2006. Relevant regulations were also revised at the same time, and the amount of the award was increased from the original NT$600,000 to NT$1 million in conjunction with revisions to the *Executive Yuan Outstanding Contribution in Science and Technology Award Implementation Regulations, Executive Yuan Outstanding Contribution in Science and Technology Award Review Committee Establishment Regulations, and National Science Council, Executive Yuan Selection Operating Guidelines for the Executive Yuan Outstanding Contribution in Science and Technology Award*. Citizens engaging in science and technology work in the natural sciences, engineering, biology/medicine/agriculture, or the humanities and social sciences whose R&D results lead to outstanding inventions or innovations, and thereby make significant, groundbreaking, and original contributions to society may be nominated to receive this award. After experts and scholars engaged by the NSC perform a preliminary assessment, a review committee consisting of the heads of government agencies, schools, and academic research organizations, plus experts and scholars affiliated with these units, performs a review, and the results are forwarded to the Executive Yuan for approval and conferral of awards.


**An awards ceremony was held on May 12, 2010 for various 2009 research awards. Shown in this photo are NSC Minister Lou-Chuang Lee (third from left), Deputy Minister Wen-Chang Chang (first on left), Deputy Minister Cheng-Hung Chen (second from right), Deputy Minister Ching-Yang Chou (first on right), Outstanding Specially-Contracted Researcher Award winners research fellow Shu-Mei Yu (second from left) and researcher Ming-Tzung Lai (third from right).**

# V. International Cooperation in Science and Technology

Apart from continuing to strengthen cooperation and interchange with technologically-advanced countries, the NSC also provided scientific and technological assistance coordinated with the government's foreign policies, thereby supporting the country's diplomatic initiatives and maintaining balance in the country's S&T development strategy.

## A. Promotion of Bilateral S&T Cooperation

In order to strengthen bilateral collaborative relationships and establish bilateral platforms for S&T interchange, the NSC has stepped up the signing of scientific and technical cooperation agreements and MOUs with foreign science and technology agencies and research organizations. A total of 98 cooperation agreements, MOUs, or other cooperation documents had been signed with parties in 42 countries and two international organizations by the end of 2010.

The NSC signed four new bilateral S&T cooperation agreements and five agreement annexes or attachments in 2010: (1) A bilateral scientific memorandum of cooperation with the Russian Academy of Sciences was signed in March; (2) a memorandum of cooperation with the Australian Institute of Marine Science was signed in Australia in April; (3) the 3rd (2011-2013) Russia-Taiwan joint research fund agreement annex was signed with the Russian Foundation for Basic Research in June; (4) a MOU was signed with the National Research Foundation of Korea in July; (5) a memorandum of cooperation was signed with the Technology Agency of the Czech Republic in September; (6) a cooperation letter of intent was signed with the four central European members of the Visegrad Group (Czech Republic, Slovakia, Poland, and Hungary) in September; (7) project-based personnel exchange program was signed with the Slovak Academy of Sciences in September; (8) a memorandum of cooperation in technology was signed with Britain's Biotechnology and Biological Sciences Research Council in November; and (9) a memorandum of cooperation attachment was signed with the Siberian branch of the Russian Academy of Sciences in December.

Furthermore, the NSC signed a MOU for an extended cooperation program in communications technology with Canada at Ottawa in December; the NSC and the Communications Research Centre Canada will bear responsibility for implementing this agreement.

## B. Participation in Major International S&T Organizations

This year the NSC continued to promote Taiwan's participation in the activities of major international S&T organizations, and encouraged international scientific and technological interchange and collaboration.

### 1. Intergovernmental Group on Earth Observations (GEO)

The Intergovernmental Group on Earth Observations (GEO) was established in February 2005 for the purpose of creating an overall earth observation system and serving as a catalyst for the integration, dissemination, and use of earth observation data in socially beneficial applications. GEO's outputs span the nine socially beneficial areas of disaster mitigation, health, energy, climate, water resources, meteorology, ecosystems, agriculture, and biodiversity, and it also performs horizontal data integration. The NSC has planned Taiwan's substantive participation in GEO's promotional strategies and implementation mechanisms via a special project, and provides technical consulting services to help relevant agencies apply to join GEO. The NSC will assist in the collection of domestic and foreign earth observation data in the future, and will share information and keep pace with GEO's progress.

### 2. European Union (EU)

Apart from maintaining bilateral cooperation arrangements with the EU's 27 member states, the NSC also encourages research teams in Taiwan to participate in the EU's Framework Programme (FP). In order to strengthen collaboration in science and technology, the NSC established the "National Contact Point in Taiwan" (NCP-Taiwan) in 2008 in order to provide EU FP-related information services to domestic research personnel. During 2009, in order to promptly access specialized information connected with FP projects, the NSC also approved eight topical NCPs respectively for projects in the five areas of energy (Energy NCP), the environment (Environment NCP), electronics / computers / communications (ICT NCP), health (Health NCP, and the social sciences / humanities (SSH NCP), and experimental projects in the three areas of food/agriculture / biotechnology (Bio NCP), nanotechnology (NMP NCP), and security (Security-NCP). These contact points will help professionals in various research areas to increase their contact with European scientists.

With regard to project funding, apart from providing funding to three more Taiwanese research teams participating in EU FP projects, the NSC also provided funding to 20 new EU FP7 Framework Programme cooking proposals, and encouraged Taiwan research teams that are already engaging in bilateral collaborative projects to jointly apply for FP projects with their partners in the EU. In addition, the NSC further provided funding to eight individuals participating in the EU's major instruments training program.

### 3. Asia Pacific Economic Cooperation (APEC)

The joint proposal by Taiwan and the Philippines to establish the APEC Research Center for Typhoon and Society was approved by the 39th APEC Industrial Science and Technology Working Group conference held at Sendai, Japan in September, and the center formally began operation in November. Furthermore, Taiwan and Korea made the joint proposal at the Sendai conference that the 3rd APEC Future Scientist Conference be jointly held at Taipei in April 2011. In addition, the

APEC Research Network for Advanced Biohydrogen Technology, which will be conducted by the Feng Chia University with NSC support, was approved by the 36th APEC Industrial Science and Technology Working Group in September 2009. Sixty experts and scholars from non-APEC countries have come to the Taiwan to participate in this project, which is proceeding smoothly.

(4) International Council of Scientific Unions (ICSU)

ICSU was established in 1931, and currently consists of 116 national members and 30 scientific union members. The vast majority of ICSU members are the highest scientific research organizations in their respective countries; ICSU can be likened to the "United Nations" of the scientific world. For many years, in its status as an NGO, ICSU has used its resources in a flexible manner to play the role of an international scientific policy advisor, and it has also successfully coordinated international efforts in the fields of scientific information, medicine, ecology, and astronomy, while providing scientific development resources to developing countries.

Former Academia Sinica President Lee Yuan Tseh was nominated at the October 2008 ICSU convention to serve as president of the next ICSU session, assumed the position of president-elect in 2010, and will formally take over as president in 2011. The NSC will assist Taiwan's participation in various ICSU affairs via a special project.

**On February 2, 2010, NSC Minister Lou-Chuang Lee (fourth from right), accompanied by Prof. Makoto Kobayashi (fifth from left), winner of the 2009 Nobel Prize in physics, are received by President Ma Ying-Jeou president (fifth from right).**

## C. Funding International Academic Interchange Activities

In order to enhance Taiwan's visibility in the international academic world, the NSC has striven to promote participation of Taiwanese teams in the activities of international scientific and technological organizations and international academic organizations, and continues to provide support for the promotion of S&T research cooperation via attendance at international academic conferences, the holding of international academic conferences, and the invitation of foreign figures to Taiwan. Furthermore, to encourage young scientists to enter the international academic sphere at an early date, since 2006 the NSC has provided funding to domestic graduate students for participation at international conferences allowing them to present their research results. This participation also expands graduate students' international perspectives, strengthens their research skills, and fosters international research collaboration.

The NSC drafted and began implementation of the "Trial Program to Subsidize Scientists and Enhance National Influence" ("Polishing Program") in 2009 in order to give greater

**Major symposia and forums held by the NSC in 2010**

| Month | Name |
|---|---|
| February | The **Taiwan- Argonne Nano-porous Structural Materials Bilateral Conference** was jointly held with the United States' Argonne National Laboratory at National Cheng Kung University |
| June | The **Advancement of Social Responses to Mega-Disasters Afflicting Mega-Cities Conference** was held jointly with the United States' National Science Foundation (NSF) in Taipei |
| June | The **3rd France-Taiwan Frontier of Science Forum** was held with France's Centre national de la recherche scientifique (CNRS) and Institut National de Recherche en Informatique et en Automatique at Yangmingshan, outside of Taipei |
| July | The **Taiwan-UK Research Collaboration Forum** was held in Britain with the INTO University Partnership |
| August | The International Symposium on Population Flows and Migrations from a Global Historical Perspective was held with the Netherlands' International Institute for Asian Studies (IIAS) at National Taiwan University |
| October | Symposia were held in Taipei, Kobe, and Kyoto with joint funding from the Japan Interchange Association |
| November | The **Japan-Taiwan Joint Research Symposium on Cryptography and Information Technology** and **3rd Taiwan-Japan Symposium on Advanced Medical Materials** and Elements was held with the Japan Interchange Association in Kaohsiung and Taipei. |
| December | The **Taiwan-Japan Symposium on Societal Aging** was held at the NSC. |

international prominence to academic researchers in their prime years possessing development potential, and train such personnel to serve as international R&D leaders. This program also seeks to encourage members of the younger generation to participate in international activities, acquire influence, and enhance their international visibility. Apart from providing domestic academic research personnel more opportunities to perfect their research skills, the program will also boost Taiwan's visibility in the international academic world via internationalized training and greater interaction with world-class scientific and technological teams. This program will be implemented on a trial basis for three years; funding was provided to 72 projects in total by 2010.

## D. Services of Overseas Science Divisions

Apart from assisting in the promotion of bilateral and multilateral S&T interchange and cooperation, the NSC's overseas science divisions also actively maintain contact with and serve overseas Chinese S&T personnel and academic associations in their service areas, and occasionally hold seminars to serve overseas Chinese scholars and exchange students. This year the "2010 Taiwan-American Biomedical Engineering Forum" was held in North America.

**The opening ceremony for the APEC Research Center for Typhoon and Society (ACTS) was held in Taipei on November 22, 2010, and a joint meeting of the ACTS steering committee and scientific advisory committee was held immediately afterwards. Meteorological experts and scientists from the US, the Philippines, Vietnam, Korea, Japan, Australia, and Taiwan were in attendance at this event. Shown here are Minister Lou-Chuang Lee (fifth from left in the front row), Minister of Transportation and Communications Mao Chih-kuo (fourth from the left in the front row), Chen Tai-jan, Vice President of National Taiwan University (first on the right in the front row), NSC Deputy Minister Cheng-Hung Chen (first on the left in the front row), and other guests.**

### Funding for International Academic Interchange Activities, 2006-2010

| Item | International collaborative research projects | Invited visits by foreign S&T personnel (person-times) | Attendance at international academic conferences[1] (person times) | Attendance at international conferences by graduate students (person-times) | International conferences held in Taiwan | Participation by teams in international academic organization conferences (groups/person times) | Polishing Program (projects) | |
|---|---|---|---|---|---|---|---|---|
| 2006 | 253 | 636 | 1,251 / 6,896 | 1,384 | 190 | 35 / 258 | - | |
| 2007 | 203 | 696 | 852 / 8,013 | 1,596 | 295 | 32 / 156 | - | |
| 2008 | 161 | 734 | 686 / 9,370 | 2,070 | 363 | 50 / 286 | - | |
| 2009 | 180 | 851 | 822 / 10,488 | 2,654 | 406 | 40 / 293 | 44 | |
| 2010 | 148 | 1,022 | 1,079 / 11,582 | 3,307 | 221 | 40 / 231 | 28 | |
| **Total** | 945 | 3,939 | 4,690 / 36,979 | 11,011 | 1,475 | 197 / 1,224 | 72 | |

[1] Attendance at international academic conferences consists of person-times funded under the categories of Department of International Cooperation projects and special-topic projects respectively.

# VI. S&T Interchange with China

Responding to the government's China policy of "taking Taiwan and benefit to society foremost" and the improved relations with China, the NSC has been actively working to create a mutually-beneficial cross-Strait situation characterized by sound, in-depth academic interchange and collaboration. The NSC relies on interchange at different levels to strengthen the development of systematic, routine cross-Strait S&T interchange mechanisms on a basis of mutual trust. At the same time, the NSC has stepped up recruiting of scientists and technical specialists in China for research in Taiwan, and will continue to promote cross-strait research projects on topics of common importance in order to achieve substantive interchange with China. The NSC is further expanding cross-Strait academic interchange organizations and encouraging the holding of relevant forums. The following are the cross-straits interchange regulations drafted in line with the nation's overall China policy and the results of their implementation:

In accordance with the *Operating Guidelines for Subsidies for the Recruitment of Visiting S&T Personnel*, the NSC provides subsidies to research organizations for the recruiting of S&T personnel from China for participation in scientific research in Taiwan; such subsidies were provided 135 person-times in 2010.

Based on the principle of mutual benefit, the *Operating Guidelines for Subsidies for the Holding of Cross-straits Academic and S&T Conferences* encourage and support the holding of cross-straits conferences by academic or technological organizations or universities, and thus provide a channel for contact between academic and technological personnel in China and Taiwan. Subsidies were provided for 57 cross-straits conferences in 2010. Furthermore, these guidelines were revised in order to ease restrictions on funding items and allow applicant organizations to use funds as they see fit, in a flexible manner; the revisions will take effect on January 1, 2011.

The *Guidelines for Funding the Invitation of Leading Chinese S&T Personnel to Taiwan for Short-term Visits* seek to promote the cross-straits sharing of science and technology and strengthen bilateral trust and understanding; these guidelines are meant to help research organizations to invite to Taiwan individuals who are the managers of important S&T organizations in China and who possess special skills and can benefit the applicant organization's research or S&T development; while in Taiwan, such figures shall give public lectures and participate in conferences. Funding was provided for the visits of 43 such persons to Taiwan in 2010. In addition, the *Guidelines* were revised to extend applicability to S&T personnel from the Hong Kong and Macao areas, adjust the items for which the invitation subsidies could be provided, and increase the subsidy amounts; these revisions will take effect on January 1, 2011.

A total of 2,022 mainland Chinese professionals were authorized in 2010 to come to Taiwan to perform long- and short-term academic, scientific, and technical academic activities following an application and review process.

The NSC provided subsidies for National Taiwan University and the China Association for Science and Technology to jointly hold the "2010 Cross-Strait Science (Popular Science) Communications Seminar and Expo," which established a specialized popular science communications interchange platform and enabled (popular) science communications personnel in Taiwan and China to share research results, discoveries, and each others' popular science communications efforts. This event, which will be alternately held in Taiwan and China, will promote discussion of the dissemination of concepts, scientific knowledge, and skills, as well as the sharing of experience and demonstration results.

The NSC continued to implement research on common issues with China, and announced the review and approval of various subsidies. Such joint research projects are intended to promote positive academic interchange with China and concern topics furthering the public welfare. This year's common issue was "biodiversity." In addition, the NSC also held an annual conference to draft common issues for 2012, and resolved to increase the number of annual topics and amount of annual funding in a progressive manner.

Apart from continuing to work with the National Natural Science Foundation of China to promote collaborative research on common issues, and holding a working conference in accordance with regulations, during 2010 the NSC also actively engaged in interchange with relevant Chinese academic units, promoted the holding of cross-Strait S&T forums, and continued to encourage reciprocal visits by high-level officials in charge of science and technology in order to foster the establishment of stable interchange mechanisms.

**S&T interchange with China and permit review case statistics, 2006-2010**

| Item | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|
| Recruited S&T personnel from China (person-times) | 107 | 101 | 81 | 127 | 135 |
| Cross-straits academic conferences | 42 | 45 | 48 | 61 | 57 |
| Major Chinese S&T figures invited to visit Taiwan (person-times) | 19 | 21 | 25 | 27 | 43 |
| Professional S&T activity permits reviewed (person-times) | 1,098 | 1,294 | 1,242 | 1,397 | 2,022 |

# VII. Improving the Research and Development Environment

## A. Online Services

The NSC upgraded the functions of the "English online application procedures" for researchers and the "expanded academic statistic database subsidy/grant/incentive query" service for public use in order to integrate information and make the interface easier to use; the upgraded versions feature the following content:

"English online application procedures": This service consists of English online application interfaces for the four items of "specific-topic research projects," "Academic Summit Program project proposals," "recruiting S&T manpower and cross-Strait interchange," and "subsidies for graduate students wishing to attend international conferences," and is intended to help foreign research personnel to save time completing application procedures. The service is aimed at general research in the form of specific-topic research projects, neophyte personnel, contracted research, gender and technology research, national S&T programs, national energy programs, specific-topic research by research scholars, international collaborative specific-topic research under bilateral agreements, research on emerging infectious diseases in Taiwan, and Academic Summit Program projects, and provides the following service items:

1. The English online application system, including the interface, application forms, and operating manuals, is entirely in English.
2. The Chinese and English online application systems and databases are converted to Unicode coding.
3. Generates English application form merged files.

"Expanded academic statistic database subsidy / grant / incentive query" service: This re-engineered service allows the general public to use a unified interface to query subsidy / grant and incentive information by name, agency, or subsidy / grant and incentive service item; service items include:

1. "Specific-topic research projects": The scope of available information encompasses statistics concerning specific-topic research cases, other funded cases, commissioned cases, and cases implemented on behalf of other parties.
2. "International collaborative projects": The scope of information encompasses statistics concerning attendance of domestic experts at international conferences, subsidies for participation of S&T personnel in short-term overseas research, invitation of S&T personnel for short-term visits, international academic symposia held in Taiwan, and subsidies for participation of teams at conferences held by international academic organizations.
3. "Other subsidy / grant and incentive queries": The scope of information encompasses 16 items, which include the Presidential Science Prize, Executive Yuan Outstanding Contribution in Science and Technology Award, Ta-You Wu Memorial Award, Outstanding Research Award, Outstanding Technology Transfer Contribution Award, Outstanding Industry-academic Collaboration Award, Distinguished Research Fellow Award, domestic and foreign recruiting cases, Master's thesis award, and participation of university students in specific-topic research projects. Statistical items concerning subsidies/grants and incentives have received approximately 170,000 clicks since the system went online in March 2010.

Apart from maintaining its existing application services, the NSC is currently upgrading the specific-topic funding

**Paperless online application procedure statistics, 2008-2010** Units: cases

| Item | 2008 | 2009 | 2010 |
|---|---|---|---|
| Specific-topic projects | 92,652 | 99,997 | 100,879 |
| International collaborative projects | 14,629 | 14,983 | 16,829 |
| Manpower recruiting projects | 8,352 | 12,408 | 12,304 |
| Industry-academic collaborative projects | 4,402 | 6,517 | 5,773 |

Note: Includes online applications, contract signing and request for funds, contract production, changes, application for reimbursement, and report submission.

**Paperless online review cases and person-times, 2008-2010**

| Item | Review cases | | | Review person-times | | |
|---|---|---|---|---|---|---|
| | 2008 | 2009 | 2010 | 2008 | 2009 | 2010 |
| Specific-topic project funding applications | 25,748 | 26,649 | 27,977 | 78,078 | 82,811 | 86,498 |
| International collaborative projects | 5,865 | 7,141 | 8,354 | 7,278 | 9,308 | 9,495 |
| Manpower recruiting projects | 984 | 1,867 | 1,802 | 1,240 | 2,623 | 2,468 |
| Industry-academic collaborative projects | 962 | 1,811 | 1,461 | 2,974 | 4,659 | 4,871 |

Note: Statistics concern online application cases submitted to online reviewers

management system and integrating its service-oriented framework platform and review platform in order to enhance the efficiency of specific-topic funding implementation.

In addition, the NSC's paperless online application procedures for specific-topic research project, manpower recruiting, technology R&D results, industry-academic collaborative project, and training project subsidies and awards have shown themselves capable of saving large amounts of paper and postal expenses, while shortening processing time and boosting the NSC's administrative efficiency.

The online review system allows review committee members to use the Internet to enter the NSC web site at any time or place, where they can perform tasks such as accepting projects, browsing application information, inputting review scores and comments, and producing review fee invoices. The fact that it is unnecessary to send any physical mail saves impressive amounts of money, labor, and time.

## B. Centralized Use of Major Instruments

The NSC provided funding to the following 17 schools as part of its major instrument joint use service program in 2010: National Taiwan University, National Taiwan University of Science and Technology, National Central University, National Tsinghua University, National Chiao Tung University, National Chungshing University, National Chung Cheng University, National Cheng Kung University, National Sun Yat-sen University, National Taiwan Normal University, National Dong Hua University, National Yang Ming University, National Taiwan Ocean University, Tamkang University, Chaoyang University of Technology, Kaohsiung Medical University, and National Pingtung University of Science and Technology.

The NSC's major instrument plan for 2010 built on past efforts and continued to provide equipment services needed for academic and industrial research. A total of 17 schools received funding and the services of 155 instruments were provided, and six new or replacement instruments were purchased. Funding totaled NT$217 million and 54 operating personnel were employed in instrument center service projects.

Major instruments centers provided services roughly 421,000 times in 2010, and service time exceeded 403,000 hours. The output value of instrument services could be as high as NT$467 million . Data acquired via major instrument use was expected to be used in at least 6,690 academic papers.

**Major instrument use center service statistics, 2010**

| School | Instruments | Service hours | Service cases |
|---|---|---|---|
| National Taiwan University | 20 | 46,703 | 63,224 |
| National Taiwan University of Science and Technology | 5 | 9,610 | 4,377 |
| National Central University | 10 | 18,939 | 20,349 |
| National Tsinghua University | 28 | 105,597 | 78,801 |
| National Chiao Tung University | 23 | 46,661 | 52,861 |
| National Chungshing University | 13 | 57,225 | 38,448 |
| National Chung Cheng University | 8 | 12,558 | 13,979 |
| National Cheng Kung University | 19 | 70,212 | 63,490 |
| National Sun Yat-sen University | 16 | 32,175 | 37,583 |
| Non-major instrument centers center (80 locations) | 13 | 21,429 | 30,323 |
| Total | 155 | 421,109 | 403,435 |

Source: Major Instrument Information Management System

# VIII. Management and Extension of R&D Results

As prescribed in the *Fundamental Science and Technology Act*, the right to manage and extend the results of NSC-funded specific-topic research projects, such as by patenting and technology transfer, has been granted to the implementing unit since January 22, 1999.

While domestic academic research organizations play important roles in the creation and application of knowledge, they are mostly still at the stage of accumulating practical experience when it comes to patenting R&D results and transferring technologies. The NSC drafted the *Operating Guidelines for the Management and Extension of Funded Academic Research Results* in order to help implementing organizations to boost the effectiveness of R&D results management and extension, and has adopted many performance-oriented funding and award measures since 2003. These measures include providing funding for invention patent applications by organizations implementing NSC-funded projects (including 80% of application expenses and maintenance costs for three years); and when a patent has been received, the applicants may receive an incentive depending on the country in which the patent was granted. The NSC provided funding for 80% of invention patent application expenses in 2,632 cases in 2010, and invention patent subsidies were granted in 472 invention patent cases involving the results of NSC-funded projects.

In order to assist implementing organizations to establish R&D results management mechanisms and to stimulate the management and utilization of intellectual property resulting from R&D, the NSC continued to help academic and research organizations to establish dedicated units responsible for managing and extending R&D results, and a total of 56 organizations—including a majority of the most active and capable R&D organizations—have established such units since 2003. Furthermore, to actively encourage the promotion of technological diffusion, the project-implementing organizations pay certain percentages of income from R&D results to funded organizations; this percentage is 20% in the case of agencies, schools, and government research organizations, and 50% in the case of other organizations and companies. More than NT$340 million in royalty income was generated from NSC-funded R&D results in 2010, and the NSC received close to NT$39 million of this.

**Expense subsidies and incentives for invention patents based on the results of NSC-funded specific-topic projects, 2006-2010**

| Item | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|
| Invention patent applications receiving partial expense subsidies from the NSC (cases) | 1,758 | 2,017 | 2,184 | 2,187 | 2,632 |
| Invention patents resulting from NSC specific-topic research projects receiving incentives (cases) | 416 | 489 | 420 | 397 | 472 |

**Numbers of technology transfer cases resulting from NSC-founded specific-topic project results and royalties, 2006-2010**

| Item | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|
| Number of technology transfer cases (cases)[1] | 1,072 | 1,244 | 714[2] | 911[2] | 888 |
| Contract royalties (NT$1 m) | 133.0 | 145.0 | 243.9 | 721.2[3] | 341.0 |
| Royalties paid into the Science and Technology Development Fund (NT$1 m) | 26.5 | 28.5 | 24.9 | 36.7 | 38.5 |

[1] Technology transfer cases include preliminary technology transfer cases and technology transfers finalized in accordance with NSC industry-academic collaborative project regulations.

[2] The academic-industrial project application interval was revised to once per year in 2008, and technology utilization and extension is no longer limited to preliminary technology transfer and licensing. There were 714 technology transfer cases resulting from funded projects in 2008. The application interval was changed to twice per year in 2009, and the number of technology transfer cases accordingly grew.

[3] The number of biotechnology technology transfer cases increased in 2009 compared with 2008. Since exclusive licensing is the norm for cases of this type, the licensing period tends to be relatively long, and royalties tend to be fairly high, royalty income from R&D project results grew significantly in 2009 compared with past years.

# IX. Increasing Citizens' S&T Literacy

The NSC is actively promoting public science education in an effort to boost citizens' scientific literacy, and expects every citizen to be interested in science and understand scientific applications, enjoy the wonders of science, and appreciate the beauty of science. Apart from soliciting and funding popular science education research projects, the NSC plans and funds various science activities, science contests, science exhibitions, and popular science lectures ("The Outlook" in Taipei, "Sharing the Master's Vision" in Taichung, and "Reading the Great Science Masters" in Kaohsiung), supports science volunteer teams, maintains the popular science web site "Science Garden," and provides information concerning various types of popular science activities and means of viewing science videos and playing online science lectures. The NSC hopes to make science an integral part of the cultural fabric and everyone's lives. The following were some of the most important results in 2010:

The NSC funds the holding of popular science activities, including popular science educational material R&D, training for popular science education manpower, workshops, exhibitions, lectures, hands-on activities, competitions, and science travel, etc. Some of the key topics of these activities include boosting female students' interest in science and self-confidence in engaging in scientific work, shrinking science learning gaps, large-scale popular science contests, and science in life. In general, the NSC hopes to increase citizens' scientific knowledge through the planning and implementation of innovative, diversified, accessible, and fun popular science education. A total of 185 funded projects were implemented this year, including "Use of Integrated Teaching to Enhance Knowledge of Marine Ecology among Schoolchildren in Remote Areas" and "Hands-on Popular Science Activity Series," which both attracted enthusiastic participation. Furthermore, when the use of the Internet and other platforms is considered, people came in contact with popular science activities more than 700,000 person-times.

The 2010 Science Season had the topic of "Mobilize to Save the Earth－Climate Change Exhibition," and featured a five-year permanent exhibition at the National Science & Technology Museum that includes: an energy-saving mechanical car, a green exhibition hall constructed with environmentally-friendly building materials, the Aquamarine Planet Theater, a multimedia journey under the sea, an interactive artificial tree, and an opportunity to be a weather broadcaster. The exhibition also uses new computer technology, including a multi-touch, versatile access system and mobile barcode technology, to illustrate the consequences of runaway climate change, let viewers portray the world of their imagination, and visit the mobile museum to learn more about the environment.



**The 2010 Science Season event "Mobilize to Save the Earth－Climate Change Exhibition" was held at the National Science & Technology Museum starting on August 8, 2010, and will be a five-year permanent exhibition at the museum. The varied and instructive items at this exhibition made it an ideal venue for environmental education.**

The Integral Project of Facilitating Science Communication, which began in 2007, contains eight key projects with the respective subjects of media production, manpower training, international cooperation, knowledge construction, database compilation, incentives, performance assessment, and academic research. The media production project providing funding for the seven science videos, four science news reports, and four science programs in 2010; since 2006, a total of 39 videos, 31 news reports, and 20 programs have received funding. The viewing rates of made-in-Taiwan science videos and programs reached new highs, and the viewing rates of the four programs "The Power to See the Future," "Taiwan's Heartbeat," "Discovering the Mysteries of Taiwan's Geology," and "Web Rumor Go Go Go" were all higher than those of the Discovery Channel's science programs during the same time periods, which shows that Taiwan's program production ability meets high standards. In a particularly impressive achievement, seven science programs receiving NSC-funded were nominated for the 45th Golden Bell Awards for TV, including the Educational ／Cultural Program Award, Children ／Youth Program Award, Variety Show Award, Animated Program Award, Non-Dramatic Program Director Award, and Children ／Youth Program Host Award.

In the area of manpower training, funding was provided for "audiovisual record training workshops for research assistants," which trains audiovisual assistants in university science laboratories and will help future scientists and laboratory assistants produce multimedia recording of every step of research processes. These training workshops showed how to transform recording the experimental process into a highly-accessible science, and how to use multimedia recording tools to change tedious, mundane procedures into dynamic and interesting actions. Nine professors' laboratories participated in these workshops, which provided training to 21 undergraduates and graduate students working as part-time and full-time laboratory assistants.

In the area of international cooperation, a team from National Chengchi University collaborated with the University of Southern California to acquire the "Digital Interactive Trans-Media" concept and technology; this collaborative effort completed the "National Formosa" interactive web site (http://www.naturalformosa.nccu.edu.tw/), and the production team is now working in industry. The NSC expects to complete the deployment of interactive multimedia on multiple media, including TV, the Internet, cell phones, and new media (iPad, Google, Youtube, Facebook, Twitter), during 2011. Furthermore, Shih Hsin University cooperated with Britain's Screenhouse Productions to produce five high-resolution science videos in Taiwan after a one-year preparatory period; not only does the quality of these videos meet international standards, the video specifications are also completely consistent with the specifications of international channels. These were the first such videos from Taiwan to obtain play on international channels via a proposal of the World Congress of Science and Factual Producers (WCSFP), and were highly effective. Negotiations concerning the cooperation contract will soon be conducted.

An international symposium on the topic of "Scientific Communications: Theory and Applications" was held in 2010; eight foreign scientific communication specialists--including Paul Bader, creative director of Screenhouse Productions, Prof. Sharon Dunwoody of the University of Wisconsin, EU Science Media Consultant Corantine Guillot, and Stephen Hunter, Vice President of Production for National Geographic Television International--gave keynote lectures and hosted workshops. This symposium included display of works, presentation of papers, and discussions on specific topics, and recommendations concerning scientific communications policy; beyond promoting mutual dialog and understanding between scientists, communications scholars, and media experts, the event also strengthened the domestic consensus to put scientific communications on a systematic basis as quickly as possible.

**List of NSC-funded science videos and programs nominated for the 2010 Golden Bell Awards**

| Award | Video/program |
|---|---|
| Educational ／Cultural Program Award | Sunart video "Traveling with Energy" |
| Children ／Youth Program Award | Taiwan Indigenous Television program "Little Atoms of Science" |
| Variety Show Award | TTE program (produced by Jason's Entertainment Production) "One Million Elementary Schools" |
| Animated Program Award | Public Television video (produced by YAOX5D) "Popular Science－Galileo's Pendulum" |
| Non-Dramatic Program Director Award | Tzu Chi Culture and Communication video "Discovering the Mysteries of Taiwan's Geology: Story of Volcanoes" (directed by Feng Chen-lung) |
| Children ／Youth Program Host Award | Public Television program "Rumor Go Go Go" (hosted by Hsueh Chi-kang and Weng Tze-man |
| Children ／Youth Program Host Award | Taiwan Indigenous Television program "Little Atoms of Science" (hosted by Daowusi (Gen Zhixin) |

# X. Publications

### *Science Development*

First published in 1973, the monthly *Science Development* was originally intended to report the results of NSC-funded research, S&T policies, and S&T trends, etc. It was changed into a general popular science magazine in January 2002, and strives to make science and technology be more accessible and relevant. Well-illustrated reports enable general readers to understand scientific developments and achievements in Taiwan and around the world, promote interdisciplinary interchange, strengthen links between science and the humanities, and increase the public's scientific knowledge. This magazine won the Executive Yuan's Outstanding Government Publication Award from 2002 to 2007, and also won the National Publication Award twice.

### *National Science Council Review*

First published in 1963, the annual *NSC Review* reports on the NSC's key undertakings and results for the year, enabling citizens concerned about scientific and technological affairs to find out about the NSC's promotion of S&T development and its achievements.

### *National Science Council Review* (*English*)

Published since 1965, the English version of the *NSC Review* reports in English on the NSC's key services and results for the year, enabling interested persons overseas to keep track of the NSC's promotion of science and technology and its achievements.

### *Indicators of Science and Technology*

The 2010 *Indicators* contains four major sections: The first section analyzes Taiwan's R&D inputs and outputs, and makes comparisons with other major countries. The second section consists of comparative data concerning R&D activities in various countries. This third section provides statistical data concerning S&T activities in Taiwan, including a breakdown of R&D funding and manpower by sector, the government's S&T budget and R&D budget, S&T results, and science park R&D data; a new part concerning biotechnology R&D funding has been added to this section this year. The fourth section consists of appendices explaining the survey, defining terms, and providing the survey questionnaire and comparisons of OECD and Taiwan industry classifications.

### *Journal of Biomedical Science*

This English-language international academic periodical is edited by domestic scientists, and the editorial committee consists of domestic and foreign experts and scholars. There is a strict review system, and the journal is published in English by a prominent international publishing company. First published in 1994, the *Journal of Biomedical Science* was originally a quarterly, but was changed to a bimonthly in 1996. In order to disseminate academic research results faster and more widely, this journal was changed to open access in 2009; any user can freely use papers via the Internet, and research personnel can share the periodical's resources in order to promote academic development. It had an *SCI* impact factor of 2.007 according to the 2009 *Journal Citation Reports* (*JCR*), and is one of the most representative biomedical journals in Asia.

### *International Journal of Science and Mathematics Education*

First published in 2003, this quarterly international academic periodical was changed to a bimonthly in 2009. It is edited by domestic scholars with the help of an editorial committee consisting of prominent domestic and foreign experts in relevant areas, and is published by a prominent international publishing company. The journal employs a strict double-blind peer review system. Articles are received from many countries worldwide, of which nearly three-fourths are non-English-speaking countries. It is a very representative educational research journal presenting viewpoints from non-English-speaking countries. This journal was awarded an "A" rating (top 5%-20%) among more than 20,000 academic periodicals worldwide by the Australian Research Council in 2010.

### *East Asian Science, Technology and Society: an International Journal*

First published in 2007, this English-language quarterly is published by a prominent international publishing company. It contains articles, book reviews, and short communications concerning science, technology and society (STS). It is hoped that comparative research in this journal concerning the economic phenomena of East Asia will enable the emergence of STS outlooks differing from those prevailing in the West, which will underscore Taiwan's contribution to the international STS academic community. Apart from a domestic chief editor, the journal has invited experts and scholars from Taiwan, Japan, Korea, Britain, the US, and Australia to form the editorial committee. The journal is relying on its rigorous review system to continuously to steadily improve the quality of articles.

The foregoing publications can all be viewed on the NSC web site: http://www.nsc.gov.tw/.

Chapter

4

# Development of Science Parks

Hsinchu Science Park

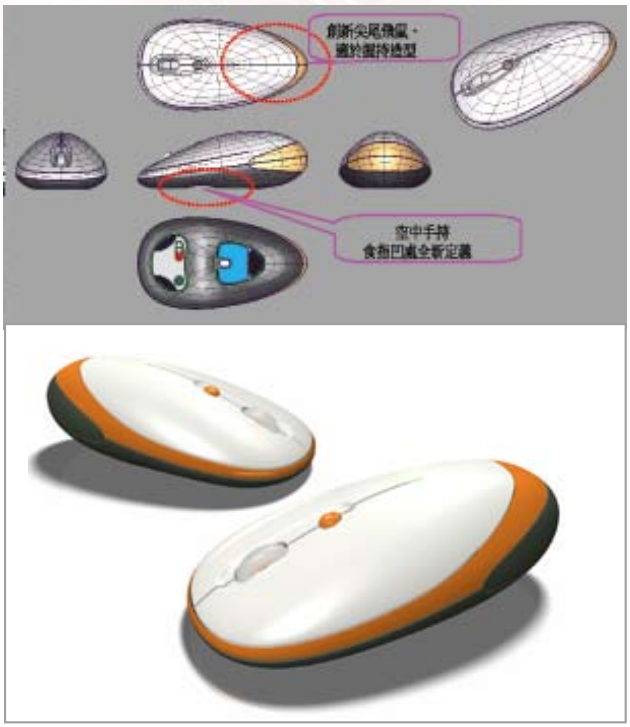
Southern Taiwan Science Park

Central Taiwan Science Park

# I. Hsinchu Science Park

Taiwan's science parks were established for the purpose of attracting high-tech industries and manpower, encouraging domestic technological innovation, promoting industrial upgrading, balancing regional development, and achieving nationwide economic growth. The science park system currently consists of three core parks in northern, central, and southern Taiwan: The Hsinchu Science Park is a hotbed of the semiconductor and optoelectronics industries; the Central Taiwan Science Park specializes in optoelectronics, aerospace, and precision machinery; and the Southern Taiwan Science Park is a stronghold of the optoelectronics industry. These three science parks together give Taiwan a key advantage in the field of technology. The science park system is also actively developing biomedical parks in line with the government's industrial policy. In the future, a north-south biotechnology corridor in western Taiwan will provide new opportunities for rapid national economic development.

In existence for 30 years, the Hsinchu Science Park consists of 653 hectares in Hsinchu, 123 hectares at the Zhunan site, and 107 hectares at the Longtan site. A total of 449 companies were operating the park as of 2010, and employed 136,548 persons. The park's firms had aggregate revenue of NT$1.19 trillion during the year, and had cumulative paid-in capital in excess of NT$1.08 trillion. With regard to attracted investment, 35 investment applications were approved in 2009, and these new investment cases called for capital investment of NT$25.1 billion. Forty-three companies already operating in the park also applied to increase investment by a total of NT$57.2 billion. As for manpower training, this year National Chiao Tung University and other academic research and educational institutions were commissioned to provide in-service training classes; such training was provided 9,698 person-times.



**The winner of this year's Innovative Product Award was the Navii Airmouse®, which employs a 100% in-house developed 3D MEMs gyroscopic motion sensing module. This mouse can switch back and forth between a conventional 2D laser and the 3D gyroscopic (3D gyro) motion sensing modes while it is used to control the cursor and clicks on functions in the Windows operating system. It uses unique motion sensing resolution computing technology in order to achieve a cursor control resolution of 1,600 dpi no matter whether used in 2D desktop mode or 3D mid-air mode. Apart from high cursor resolution, it also offers positioning stability and disturbance filtering ability better than any other products in its class, and provides users with a satisfying degree of sensitivity.**

**Overview of Hsinchu Science Park Industries, 2010**

| Item | Number of firms | Number of employees | Capital (NT$100 m) | Revenue (NT$100 m) | Revenue growth (%) |
|---|---|---|---|---|---|
| Integrated circuits | 192 | 81,326 | 6,956 | 8,008 | 33 |
| Computers and peripherals | 53 | 12,567 | 846 | 762 | 22 |
| Communications | 51 | 7,641 | 247 | 351 | 30 |
| Optoelectronics | 92 | 30,391 | 2,590 | 2,439 | 40 |
| Precision machinery | 28 | 2,620 | 85 | 223 | 92 |
| Biotechnology | 30 | 1,644 | 69 | 52 | 21 |
| Other[1] | 3 | 359 | 20 | 34 | 48 |
| Total | 449 | 136,548 | 10,813 | 11,869 | 34 |

[1] Includes other science industries and other park enterprises

**Growth of the Hsinchu Science Park, 2006-2010**

| Item | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|
| Revenue (NT$100 m) | 11,209 | 11,462 | 10,080 | 8,835 | 11,869 |
| Increase / decrease (%) | 13 | 2 | -12 | -12 | 34 |
| Companies | 395 | 416 | 430 | 440 | 449 |
| Increase / decrease (%) | 3 | 5 | 3 | 2 | 2 |
| Employees | 121,762 | 129,512 | 130,577 | 132,161 | 136,548 |
| Increase / decrease (%) | 6 | 6 | 1 | 1 | 3 |
| Manpower training (person-times) | 8,289 | 7,757 | 10,530 | 10,681 | 9.698 |
| Increase / decrease (%) | 5 | -6 | 36 | 1 | -9 |

After many years of development, land use in the Hsinchu Science Park is close to saturation. To accommodate the needs of industry and the country's future growth, the Science Park Administration is actively developing the Tongluo, Hsinchu Biomedical Park, and Yilan sites. Located in Tongluo Township, Miaoli County, the Tongluo site offers a usable area of 350 hectares; plans call for the development of IC design, advanced system in package (SiP), digital living, avionics and aerospace, and biotech/biomedical industries, and the establishment of a Hakka culture park.

The Hsinchu Biomedical Park occuping 38 hectares will focus on knowledge innovation and incubation, while chiefly serving as an industrialization incubator for the biomedical sector. The park will consist of three main centers (National Hsinchu Hospital, Biomedical Technology and Product Center, and Industry and Incubation Center) encompassing hardware facilities, medical treatment, manpower, industry & commerce, and industrial services. This park is currently recruiting firms.

The Yilan Park will include 71 hectares at the Chengnan site, which will act as a knowledge service park. Land acquisition tasks have been completed, and site preparation and development tasks are now underway.

# II. Southern Taiwan Science Park

The Southern Taiwan Science Park (STSP) was established in order to shrink the development gap between northern and southern Taiwan, while stimulating industrial development in southern Taiwan. The STSP includes science parks in Tainan and Kaohsiung counties. Twenty-five more firms were approved to occupy the Park, a total of 167 companies had been authorized to invest in the Park, and 133 had already occupied facilities and begun operations during 2010. The sales revenue of park companies was NT$606 billion during the year, and employment reached 56,388. The leasing of land at the Tainan and Kaohsiung sites reached 85.82% and 82.96% respectively.

Thanks to the STSP's vigorous recruiting efforts and establishment of a safe, superior investment environment, the following industry clusters have already taken shape:

## A. Optoelectronics industry

The STSP plays a key role in the flat panel display industry, and the up-／downstream cluster established by the Chi Mei Group and HannStar occupies a central position in this industry. Based on its localized development concept, the Chi Mei Group has established seven panel plants at the STSP, and has also established Chi Mei Electroluminescence within the Park to bear responsibility for research and development of OLEDs (organic light emitting diodes). In order to accelerate expansion of capacity, Chi Mei Optoelectronics is building a 6th-generation plant at the nearby Tree Valley Park and an 8.5th-generation plant at the STSP's Kaohsiung site. HannStar has two panel plants in the Park. Now that the STSP's optoelectronics industry has spilled over into the nearby Tree Valley Park, it possesses the most complete up-, mid-, and downstream TFT-LCD display industry cluster in Taiwan, which encompasses upstream key elements, mid-stream panels, and downstream applications.

The surging demand for smart phones and computers has spurred the rapid development of touch control panels, and Sintek and Chi Mei currently have touch control panel plants in the STSP. Thanks to the availability of support in the form of element, materials, and equipment suppliers, the touch control panel industry is expected to grow rapidly in the near future.

## B. Green energy industry

The ongoing global development of alternative energy has caused the demand for green energy products to increase steadily. Responding to international industry trends, the STSP has actively recruited firms in green industries, which chiefly include solar power, LEDs, and lithium batteries for electric vehicles. A solar power industry cluster encompassing upstream materials, mid-stream batteries, and downstream modules and products has already taken shape in the STSP. As for the LED industry, the STSP has vigorously recruited LED firms, and hopes that the presence of major manufacturers will attract upstream materials suppliers and downstream packaging firms and systems integrators, forming an industry cluster. With regard to the electric vehicle lithium battery industry, E-One Moli Energy Corp. is currently the world's fifth largest manufacturer of lithium batteries for electric vehicles. In order to strengthen green energy and solar power testing and certification capabilities, the Park has had the Institute of Nuclear Energy Research establish a concentrator photovoltaic power generation R&D and certification center, which is providing photovoltaic battery epitaxy, process, and measurement technologies, and has determined testing guidelines. This facility is promoting the development and integration of the domestic photovoltaic industry, and establishing a certification system meeting international standards. The green communications laboratory established by the Park's

**Overview of industries in the Southern Taiwan Science Park, 2010**

| Item | Firms | Employment (persons) | Capital[1] (NT$100 m) | Revenue (NT$100 m) | Revenue growth rate (%) |
|---|---|---|---|---|---|
| Integrated circuits | 13 | 15,857 | 984,813 | 2,130.0 | 41.9 |
| Optoelectronics | 45 | 31,855 | 241,561 | 3,472.4 | 21.5 |
| Precision machinery | 43 | 4,191 | 15,167 | 331.2 | 111.8 |
| Biotechnology | 44 | 1,413 | 18,817 | 53.6 | 12.7 |
| Telecommunications | 12 | 895 | 6,510 | 32.3 | 60.6 |
| Computers and peripherals | 3 | 260 | 2,820 | 13.9 | 74.0 |
| Other[2] | 7 | 1,917 | 1,583 | 2,625.4 | 27.6 |
| Total | 167 | 56,388 | 1,271,271 | 6,058.8 | 31.41 |

[1] Includes capital increases

[2] Includes other science industries and other park enterprises

Telecommunications Technology Center in February 2010 will shorten quality and safety certification time and boost the international competitiveness of relevant domestic firms.

In the IC industry, the Taiwan Semiconductor Manufacturing Corp. (TSMC) is currently operating its No. 6 plant (8" wafer fab) and the 1st, 2nd, and 3rd phases of its No. 14 plant (12" wafer fab) in the park, and is also constructing the 4th phase of its No. 14 plant and an advanced wafer packaging plant. The 1st, 2nd, 3rd, and 4th phases of the United Microelectronics Corp.'s (UMC) No. 12A plant in the Park have all entered the mass production stage. The STSP has already become the home of one of the country's most important 12" wafer production clusters.

## C. Biotechnology industry

Biotechnology is one of the STSP's key industries. Fourteen biotech firms were authorized to move into the Park during 2010, and the Park now contains 44 biotech companies in such areas as pharmaceuticals, testing reagents, and medical equipment. Vaccines and pharmaceuticals is currently the main biotech area, and pharmaceutical and nutriceutical food industry clusters are taking shape. The "Southern Taiwan Biotechnology & Medical Equipment Industry Cluster Development Plan" has attracted 25 firms to the Park, including major domestic orthopedics firms, the country's largest manufacturer of artificial teeth roots, laser beauty instrument manufacturers, a producer of NMR breast imaging equipment, and a medical alloy manufacturer.

**Growth of the Southern Taiwan Science Park, 2006-2010**

| Item | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|
| Revenue (NT$100 m) | 4,516.1 | 5,588.7 | 5,475.0 | 4,610.5 | 6,058.8 |
| Increase or decrease (%) | 28 | 24 | -2 | -16 | 31.41 |
| Number of companies | 144 | 155 | 158 | 156 | 167 |
| Increase or decrease (%) | 4 | 8 | 2 | -1 | 7 |
| Employment | 47,371 | 54,115 | 48,136 | 48,626 | 56,388 |
| Increase or decrease (%) | 15 | 14 | -11 | 1 | 16% |
| Manpower training | 1,724 | 1,902 | 2,046 | 2,920 | 3,504[1] |
| Increase or decrease (%) | 12 | 10 | 8 | 42 | 20 |

[1] Includes in-class training (2,906 persons) and advanced technology lectures and benchmark corporate leader lectures (598 persons).

# III. Central Taiwan Science Park

The Central Taiwan Science Park (CTSP) was established for the purpose of attracting high-tech industries and manpower, encouraging domestic technological innovation, promoting industrial upgrading, balancing regional development, and achieving nationwide economic growth. In view of these goals, the CTSP has consistently worked to maintain an international outlook and combine the four functions of production, living, the ecology, and life in one superior industrial park. The park was established in 2003, and is located near a major north-south transportation hub. Air, sea, and land transportation are all very convenient. Established in the wake of the Hsinchu and Southern Taiwan science parks as another center of high-tech industry, the CTSP has successively developed Taichung, Huwei, Houli, Erlin, and Jhongsing Advanced Research Park sites over the past seven years. The following are the results achieved at each site:

**A. Taichung, Huwei, and Houli sites: A center of the 12"-wafer and optoelectronics industries; plentiful R&D capacity**

The Taichung, Huwei, and Houli sites are all open to occupancy. Due to its central geographical location spanning Taichung county and city, and its close proximity to Taichung International Port and Taichung International Airport, the Taichung site enjoys convenient transportation and a strong foundation of commercial development; this site offers excellent living conditions and is highly attractive to high-tech firms and technical manpower.

The Taichung park primarily contains optoelectronics firms producing TFT-LCDs and LEDs, DRAM manufacturers, precision machinery firms, and biotech firms. Winbond and ProMOS have recently completed four 12" wafer plants in the park.

The firms occupying the Huwei site mainly include upstream producers of color photoresist materials for the panel industry, auto air bag canisters, electronic-grade glass fibers, pharmaceuticals, and polysilicon for use in photovoltaic applications.

Firms at the Houli site chiefly specialize in integrated circuits, optoelectronics, film-type photovoltaic batteries, precision machinery, lithium batteries, and solar optoelectronics. The DRAM-manufacturer Rexchip has completed two 12" wafer plants at this park.

Central Taiwan is a stronghold of the precision machinery industry, and 33 precision machinery firms have occupied the CTSP thus far, making it numerically the largest industry in the Park. By providing nearby optoelectronics and integrated circuits firms production equipment, the precision machinery industry is reducing production costs and increasing industrial competitiveness. In addition, a total of 15 biotech firms have been authorized to move into the CTSP.

In the area of industrial-academic collaboration, the CTSP has successfully acquired eight venture incubation centers affiliated respectively with National Chungshing University, National Chi-Nan University, Feng Chia University, Chaoyang University of Technology, National Chin-Yi University of Technology, National Formosa University, National Yunlin University of Science and Technology, and Mingdao University. Furthermore, the CTSP has enhanced its R&D resources by acquiring the central Taiwan knowledge base and grid computing development center of the National Center for High-Performance Computing and the central Taiwan R&D center of the Taiwan Development Institute.

In order to effectively promote industrial-academic training collaboration, the CTSP has established the "Academia-Industry Consortium for Science Parks in Central Taiwan" in collaboration with National Chungshing University; the consortium's members consist mainly of firms located in the park, nearby high-tech firms, and universities in central Taiwan. By bringing enterprises together with university manpower and instructional resources, the CTSP is accelerating the training of professional and technical manpower, which will promote technological upgrading in industry and help realize the science park's vision and goals.

The CTSP established promotional committees in the employing major areas of optoelectronics, nanotechnology, biotechnology, digital communications, semiconductors, precision machinery, technology management, and energy this year, and hopes that the integration and sharing of resources in these areas will promote even more industry-academic collaboration in central Taiwan, transforming the CTSP into an all-round modern, high-tech science park.

**B. Erlin site: Focusing on optoelectronics and energy-conserving green energy**

Thanks to the CTSP's excellent technology development and operating conditions, high-tech domestic and foreign firms continue to apply to occupy park sites or expand their existing plants. Responding to corporate demand, the CTSP Administration has completed its Erlin site expansion plant and begun recruiting companies. The park's goals are to foster the development of a new generation of high-tech firms, give industry more room for development, and boost firms' international competitiveness. The Erlin site is intended chiefly for optoelectronics and energy conservation / carbon reduction green energy firms, including companies in the solar power, wind power, geothermal, biofuels, high performance battery, and LED

**Land Use in the Central Taiwan Science Park, 2010** **Units: hectares**

| Item | Total area | Leasable area (A) | Leased area (B) | Allotment rate (%) | Remaining leasable area (C=A-B) |
|---|---|---|---|---|---|
| Taichung site | 413 | 186.94 | 186.94 | 100 | 0 |
| Huwei site | 97 | 42.15 | 33.38 | 79.19 | 8.77 |
| Houli site | 255 | 141.85 | 141.85 | 100 | 0 |
| **Total** | 765 | 370.94 | 362.17 | 97.63 | 8.77 |

industries. When the time comes, the high-tech industry clusters at this site will help realize the vision of transforming Taiwan into a Green Silicon Island.

### C. Jhongsing Advanced Research Park: Leading Taiwan's industry into the high-value R&D era

The 259-hectare Jhongsing Advanced Research Park (including the South Neilu area) is located within the urban planning scope of Chung-hsing New Village, Nantou County. The chief goals of this park are to attract government and academic research organizations, provide R&D resources, and create a high-quality research and living environment. This multifunctional park is intended to bring together research units and organizations in such areas as cultural creativity, administrative services, machinery R&D, energy R&D, environmental R&D, and other innovative areas of research and development. When the time comes, the Jhongsing Advanced Research Park will lead industrial development toward even higher quality, train top-notch research manpower, create an environment where knowledge clusters can form and interact, and serve as a key player in Taiwan's adoption of international standards. Organizations that have submitted occupancy plans include the Industrial Technology Research Institute's "Central Taiwan Industrial Innovation R&D Zone," the Institute for Information Industry's "Emerging Intelligent Technology Research Center," the National Applied Research Laboratories, Institute of Nuclear Energy Research's "Low-Carbon Energy Technology Center," the Academia Historica's and Council for Cultural Affairs' "Cultural Creativity Development Research Institute," and an agricultural technology research institute currently being established by the Council of Agriculture.

A total of 108 firms, as well as 12 research organizations and incubation centers, had been authorized to occupy sites in the CTSP from the time it was established in July 2003 up to the end of 2010, and total cumulative investment was over NT$2 trillion during that period. The results of the Park's recruiting efforts have been outstanding.

As of the end of 2010, the Taichung site was 100% allotted, the Houli site was 100% allotted, and the Huwei site was 79.19% allotted, with a remaining leasable area of 8.77 hectares.

The "Science Park Strategic Development Committee," formed by the NSC on February 25, 2008, selected the Erlin site as the first priority location of the CTSP's fourth expansion stage. This site is intended to provide land for 11th-generation optoelectronics plants, and continue to meet the needs of other high-tech firms for increasingly scarce land. The site will also allow central Taiwan's existing clusters to expand, and accelerate the region's industrial upgrading and transformation.

Land acquisition for the Erlin site was completed in 2010, and the first stage of infrastructure construction began. The site's wastewater treatment and effluent facility will be completed in mid-2013, and all public construction work is scheduled to be completed by 2017.

The establishment of the Jhongsing Advanced Research Park is intended to strengthen industrial R&D capabilities in central Taiwan and promote the redevelopment of Chung-hsing New Village. This site is geared towards R&D activities, and will not acquire any mass production operations. The NSC expects that the park will increase the vitality of the Chung-hsing New Village area, ensure a high-quality R&D and living environment, and make an immense contribution to local development. The site has an area of 259 hectares. It is anticipated that EIA review, land acquisition, and initial improvement tasks will be completed by the end of 2011, and the first R&D units will be able to move in after that time. Development of the entire site should be completed by 2019.

**Overview of Central Taiwan Science Park Industries, 2010**

| Item | Firms | Employment (persons) | Investment (NT$100 m) | Revenue (NT$100 m) | Revenue growth (%) |
|---|---|---|---|---|---|
| Integrated circuits | 8 | 5,858 | 11,182.38 | 962.80 | 89.18 |
| Computers and peripherals | 6 | 144 | 61 | 10.31 | 331.55 |
| Telecommunications | 1 | 0 | 0.2 | 0 | 0 |
| Optoelectronics | 31 | 13,935 | 8,911.87 | 2,527.07 | 38.04 |
| Precision machinery | 36 | 2,932 | 113.45 | 114.44 | 91.46 |
| Biotechnology | 16 | 136 | 41.51 | 2.47 | 27.50 |
| Other [1] | 10 | 324 | 26.35 | 8.28 | 5.12 |
| Total | 108 | 23,329 | 20,336.76 | 3,625.37 | 50.33 |

[1] Includes other science industries and other park enterprises

**Growth of the Central Taiwan Science Park, 2006-2010**

| Item | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|
| Revenue (NT$100 m) | 1,785.2 | 2,657.27 | 2,861.69 | 2,411.64 | 3,625.37 |
| Increase or decrease (%) | 193 | 48.8 | 7.69 | -15.73 | 50.33 |
| Companies | 74 | 83 | 92 | 100 | 112 |
| Increase or decrease (%) | 8.9 | 12.2 | 10.8 | 8.7 | 12 |
| Research organizations and incubation centers | 8 | 9 | 10 | 10 | 12 |
| Increase or decrease (%) | 100 | 12.5 | 11.1 | 0 | 20 |
| Employees | 13,263 | 17,494 | 20,736 | 19,845 | 23,329 |
| Increase or decrease (%) | 77 | 32 | 15.3 | -4.3 | +17.6 |
| Training[1] (person times) | 606 | 445 | 647 | 1,068 | 982 |
| Increase or decrease (%) | 742 | -26.6 | 45.4 | 65.06 | -8.05 |
| Education[2] (person times) | 455 | 1,478 | 1,162 | 1,527 | 1,789 |
| Increase or decrease (%) | | 225 | -21.38 | 31 | 17.16 |

[1] Aimed at park employees [2] Aimed at ordinary students

# 2010 National Science Council Review

Published by: National Science Council, Executive Yuan

Address：17F,106,Sec.2, Heping E.Rd., Taipei 10622, Taiwan, R.O.C.

Phone：+886(2)2737-7973

Art Editor：Design and Printed by INNODesign Co.

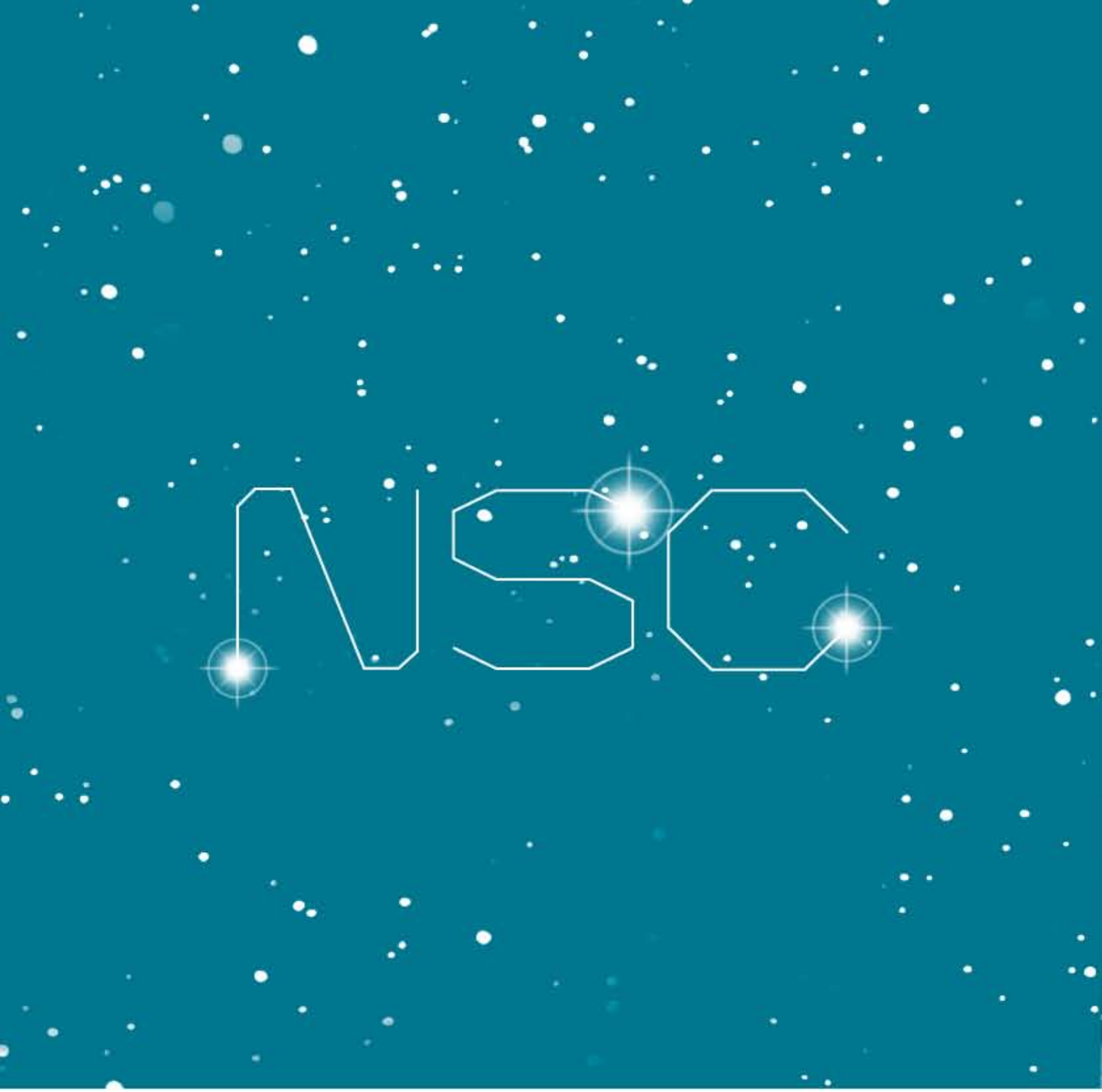
Address：5F, No.43-1, Ln.11, Sec.6, Minquan E. Rd., Neihu District, Taipei 11494, Taiwan (R.O.C.)

Phone：+886(2)7737-8585

ISSN: 1023-442x

GPN: 2005400010

National Science Council




National Science Council

17F,106,Sec.2, Heping E.Rd., Taipei 10622, Taiwan, R.O.C.
+886(2)2737-7973

ISSN 1023442X

9 771023 442009

GPN：2005400010

National Science Council