National Science Council

ISSN: 1607-3509

Science Bulletin

April 2004/Vol. 36, No. 4

Taiwan Pioneers Online Brain Circuit Virtual Reality

NCHC Helps Establish the World's First Gene Expression Database of the Drosophila Brain

The National Center for High-Performance Computing (NCHC), the Brain Research Center (BRC) of the University System of Taiwan (UST), and the United States' Cold Spring Harbor Laboratory formally signed an international cooperation agreement on February 18 for the joint implementation of the "FlyBrain Neurogenomics Project." This project calls for the establishment of the world's first interactive 3D database allowing researchers to visualize *Drosophila* brain gene expression. The completed database will be located at NCHC, and NCHC plans to offer worldwide services via the "Online Three-Dimensional Neural Circuit Image Knowledge Base Service System."

After Britain, the US, Japan, France, Germany, and China announced on April 14, 2003 that they had completed the decoding of the human genomic sequence, scientists have since turned their attention from the genomic sequence to gene expression and function. Most scientists believe that decoding genes and understanding their functions will lead to major breakthroughs in medicine and the life sciences. In addition, brain research promises to give us a better understanding of ourselves, while better meeting the real needs of our aging society. The 21st century may be the golden age of brain research. Many scientists are using the small number of model organisms whose genetic sequence has been completed – including yeasts, nematodes, *Drosophila* (fruit fly), and mice – in comparative research aimed at exploring the functions and mechanisms of the human brain and nervous system.

Fruit flies are small and easy to raise. Because they possess the ability to learn and remember, they are considered the simplest animal model that can be used to study brain function. Many learning and memory genes first discovered in fruit flies are later confirmed also true for mammals. Furthermore, fruit flies can be used as research models for many important human diseases, including Parkinsonism, Alzheimer's disease, and Huntington's disease. The Brain Research Center research team led by Dr. Chiang Ann-shyn, director of the National Tsing Hua University Institute of Biotechnology and chief investigator of the "FlyBrain Neurogenomics Project," and the Cold Spring Harbor Laboratory team led by Dr. Tim Tully are in the midst of a systematic effort involving fruit flies and seeking to identify all genes participating in the formation of long-term memories, observe the neural circuits expressed in the brain by these genes, and deduce long-term memory formation mechanisms.

The Brain Research Center's research team has developed a series of innovative high-resolution bioimaging techniques that can be used to explore the structure and function of the brain. It now plans to use these techniques over the next five years to investigate the *Drosophila* brain. According to Prof. Chiang, "As a neuroscientist, I often wonder whether the human brain is too simple and too limited a tool to ever unravel its own mysterious functions, or whether the human brain is too complex and will never be fully understood. But I know without a shred of doubt that research on the *Drosophila* brain will do much to illuminate the human brain."

According to Dr. Hsieh Chang-huain of the NCHC, the NCHC is continuing its work on computer-aided biomicroimaging techniques in an effort to provide academic researchers the research tools they need. The research team at BRC-UST uses confocal microscopy to acquire a series of biological images, which then can be used to reconstruct the three-dimensional structure of physical objects. The ability to analyze biological structures from different angles will do much to advance our understanding of the relationship between structure and function. The BRC-UST team is also developing a three-dimensional brain-mapping model that is expected to improve understanding of the relationship between human brain structure and function. Beyond providing a flood of new information for neuroscientists, this will also offer insights of major benefit to clinical medicine.

The NCHC and Brain Research Center hope to collaborate further in the future, and among their goals will be to incorporate the real-time presentation of dynamically-linked information in a three-dimensional image virtual reality system able to take brain science to an even higher level.

Dr. Tim Tully, a researcher at the United States' Cold Spring Harbor Laboratory and founder of Helicon Therapeutics, believes that the new bioimaging techniques developed by the Taiwan team will not only bring about revolutionary breakthroughs in the study of brain structure and function, but also facilitate scientific progress in many areas of the life sciences. The NCHC and Brain Research Center have jointly established the "Online Three-Dimensional Neural Circuit Image Knowledge Base Service System," which has made Taiwan the first place in the world to offer an interactive gene expression database containing three-dimensional images. As explained by Prof. Chiang Ann-shyn, this system uses high-resolution three-dimensional images to display gene expression models. And because the system incorporates biotechnology, nanotechnology, and computer imaging technology, while taking advantage of Taiwan's existing computer information industry and biotechnology expertise, it is likely to enjoy a considerable competitive advantage in the international market. When the bioimaging technology developed by the team is used in the future to map the neural circuits in the mouse and human brain, the results may be as far-reaching as the effort to map the human genome, and may make just as great a contribution to life science research and biotech applications. If Taiwan is to continue to develop advanced technology, it is not enough for the country to merely apply the newest information and technology. Taiwan must instead become an information provider, and must take advantage of the interchange of information and technology to organize interdisciplinary, international R&D teams. With focused funding support, these teams will gain the opportunity to transform Taiwan into one of the world's leading technological powers.

From Sugarcane Fields to New Silicon Valley

Southern Taiwan Science Park Enjoys High Growth in 2003

The Southern Taiwan Science Park was established in July 1996, and has since enjoyed rapid growth in sales output, growing successively from US$727 million in 2000, to US$1.474 billion in 2001, and US$3.033 billion in 2002, and US$4.568 billion in 2003. The fact that the park managed to maintain positive growth in 2003 amidst unfavorable economic conditions is indeed an impressive achievement.

Of the main technology sectors in the park, the optoelectronics industry enjoyed the best performance with 71.43% growth and a total sales figure of US$2.638 billion, accounting for 57.77% of total sales output in the park. The integrated circuits (or semiconductor) industry came in second with 25.46% growth and sales of US$ 1.791 billion, contributing 39.2% to the total sales output. The precision machinery industry came in third for sales output. In terms of sales growth rate, the biotechnology industry ranked number one in the park with 116% growth rate, followed by the precision machinery industry (103%), and the communications industry (77.5%).

As far as import/export trade was concerned, the total 2003 trade value of US$7.06 billion consisted of approximately US$3.62 billion in exports (56% growth) and US$3.44 billion in imports (48% growth). Broken down by industry, the optoelectronics industry led exports with US$1.1 billion (60% growth), and was followed by the integrated circuits industry with US$465 million (42.7% growth). The most impressive performance in exports came from the precision machinery industry, which grew at an extraordinary 393%. In terms of import, the optoelectronics industry also led this category with US$1.829 billion and an import growth rate of 171%, followed by the integrated circuits industry with an import figure of US$367 million. The greatest share of imports came from Japan, the US, and Germany, while most exports went to Hong Kong, Japan, and Korea. Most of the goods exported to Hong Kong were transshipped to other destinations. Exports to Germany grew the fastest at 935%, indicating increasing demands

for Taiwan's electronic products from that part of the world.

Investment acquisition statistics show that the park recruited 34 additional companies in 2003, and now has a cumulative total of 127 companies. Planned investments in the park currently total US$38.24 billion. At the end of last year, the park housed 31 optoelectronics companies, 31 precision machinery companies, 25 biotechnology companies, and 22 integrated circuit companies. Employment reached 21,374 persons as of the end of 2003, which represents an increase of 6,303 persons over the previous year.

According to Dr. Tai Chein, Director General of Park Administration, the park has already formed a comprehensive optoelectronics cluster, as well

as three 12-inch wafer plants established by the United Microelectronics Corporation (UMC) and the Taiwan Semiconductor Manufacturing Company (TSMC). The park is also planning to establish a dedicated biotechnology zone that will promote genetic biotechnology. Other plans include setting up the country's second experimental animal breeding center, and forming optoelectronics, semiconductor, and biotech industrial clusters.

The park is collaborating with National Cheng Kung University, National Chung Cheng University, and the Academia Sinica to establish an R&D campus. Academia Sinica has also established a biotech experiment center within the park.

Looking ahead to the future, Dr. Tai also expressed that the park plans to recruit 30 companies in 2004, and hopes to achieve a target output of US$7.35 billion and pass the 30,000-employee mark. Ultimately, the park aims to house 400 high-tech companies, generating sales of US$55.88 billion with 180,000 employees. The Southern Taiwan Science Park is poised to become an attractive and sustainable high-tech industrial campus in southern Taiwan, as well as a great economic asset for the region.

Hsinchu Science Park: A Goose that Still Lays Golden Eggs

HSP Output Expect to Exceed NT$1 Trillion in 2004

The NSC has publicly announced that the Hsinchu Science Park (HSP) enjoyed sales revenue of NT$857.8 billion in 2003, thanks largely to the revival of the world semiconductor market and much improved capacity utilization. This figure represented 22% growth over 2002. Looking ahead to the future, continuing growth in the semiconductor market has led the NSC to predict that the HSP's sales revenue will surpass NT$ 1.1 trillion in 2004, and thus achieve 28% growth over 2003.

A breakdown of sales revenue by industry shows that the integrated circuits industry continued to dominate the six major HSP industries in terms of sales. The integrated circuits industry's sales revenue of NT$564.5 billion accounted for fully 65.8% of the HSP's total sales revenue. Next came the computers and peripherals industry, whose sales revenue of NT$134.8 billion accounted for 15.7% of total HSP sales. The optoelectronics industry enjoyed the fastest sales growth (57%), followed by the biotechnology industry with growth of 30%, and the integrated circuits industry with growth of 24%.

Labor productivity in the HSP's six major sections grew by 23% to reach NT$8.43 million per person. Here the computers and peripherals industry enjoyed the best labor productivity (NT$10.97 million per person), and was followed by the integrated circuits industry (NT$9.19 million). The average productivity per unit area of the six major sections was NT$350,000 of output value per square meter in 2003, which represented growth of 21% over 2002. The computers and peripherals industry enjoyed the highest productivity of NT$ 440,000 per square meter, and followed by the integrated circuits industry with NT$410,000 per square meter.

Turning to import/export trade, total trade of the HSP amounted to NT$612.6 billion in 2003, and was up by 15.9% over 2002. This figure consisted of total exports of NT$390.8 billion and total imports of NT$221.8 billion, which were up by 40% and down by 11.1% respectively over the previous year. The HSP's five leading export countries (and their share of exports) in 2003 were Hong Kong (21%), China (17%), the US (14%), Japan (13%), and Korea (8%). Hong Kong and China collectively accounted for 38% of the HSP's exports (30% in 2002), and exports to these regions were up by 44% and 143% respectively over the previous year. This highlights the fact that China has become a main customer for the HSP's high-tech products. The HSP's imports derived in large part from the high-tech countries of Japan (29%) and the US (20%).

As for attracting investment, the Science Park Administration of the HSP recruited 86 new companies in 2003, including 32 companies establishing plants in the Central Taiwan Science Park. Of these, 11 were in the precision machinery industry, followed by seven in the optoelectronics industry, six in the biotechnology industry, three in the computers and peripherals industry, two in the integrated circuits industry, two at the incubators, and one in the telecommunication industry. Of the 54 firms establishing plants at the HSP, 26 were in the integrated circuits industry, followed by ten in the computers and peripherals industry, seven in the biotechnology industry, four in the telecommunication industry, three in the optoelectronics industry, two in the precision machinery industry, and two in R&D centers. These figures show that the Hsinchu and Central Taiwan science parks have acquired different industry structures.

As of the end of January 2004, a total of 38 firms were approved to establish facilities at the Central Taiwan Science Park. These included two integrated circuits firms, two computers and peripherals firms, one digital content firm, 11 optoelectronics firms, 12 precision machinery firms, five biotechnology firms, two telecommunication firms, and three incubator startups. The total amount of proposed investment approached NT$430 billion. Among the tenants, AU Optronics Corp. has already begun work on sixth- and seventh-generation TFT-

LCD plants, and Winbond Electronics Corp. and ProMOS Technologies Inc. have committed in excess of NT$100 billion in investment for 12" wafer plants to be built starting in March 2004.

Vigilantly Guarding the Environment

Development of an Automatic VOC Pollutant Monitoring System

The air we breathe and the water we drink contain various amounts of volatile organic compounds (VOC). These pollutants include benzene, an assortment of benzene derivatives, and chlorine-containing compounds. Many are either carcinogenic or mutagenic. Because VOCs may come from a wide range of sources – including oils, gas leaks, gas combustion, the petrochemical industry, electronics industry, and vehicular exhaust – finding effective ways of performing automatic monitoring has become an important issue. Responding to this need, the National Central University (NCU) Department of Chemistry has been developing an "Air and Water VOC Pollutant Automated Monitoring System" with support from the NSC and the Environmental Protection Administration (EPA). Prof. Wang Jia-lin, the project's chief investigator, has developed a number of automated VOC analysis and monitoring technologies involving both hardware and software innovations. Prof. Wang is now looking forward to the deployment of such low-cost monitoring systems for applications in various situations in Taiwan.

Taiwan has become a highly developed country, and suffers from severe environmental pollution. The air and water in Taiwan are often polluted with several dozen or even several hundred types of VOCs, including alkanes, alkenes, aromatic compounds, aldehydes, ketones, and some polycyclic hydrocarbons. While some of these VOCs derive from natural sources, the vast majority are released by human activities, particularly industry and transportation. The only way to investigate the distribution of these pollutants was once to take air or water field samples and bring them back to the laboratory for analysis. This was extremely labor- and resource-intensive, and the body of data remained rather sparse. In contrast, monitoring stations equipped with automated analytical instruments can monitor the air and water at high frequencies on an unattended and continuous basis, enabling timely detection of pollution incidents and even early warnings.

According to Prof. Wang, pollution monitoring and reduction of emissions will be a key part of the process of assessing industrial production costs in the future. Because of this, the monitoring system his team has developed will have a very large potential market, and will also be in demand among academic users. While similar products are currently on the market, almost all of them suffer from three shortcomings: (1) They are manufactured overseas. (2) They offer only single functions, can test only either air or water samples, and can test only one sample at a time. In contrast, the system developed by the NCU team can automatically test water, air, or soil samples with only a few tweaks or the addition of a different module. (3) Most systems are extremely costly. Most imported systems cost two to three times that of the NCU system, which will bear a price tag of around NT$600,000.

The NCU team has also successfully developed other automated instruments for monitoring trace levels of methane and carbon monoxide in the air, and has also produced an online VOC early warning system to safeguard our living environment.

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http://nr.stic.gov.tw/ejournal/SciNews/scibulletin.htm
Subscription price for each copy: US$1.00
Payment must be made in US dollars by a check payable to National Science Council.

國　內：每份新台幣 25 元，訂閱請利用郵政劃撥儲金帳戶 01001541 號
戶　名：行政院國家科學委員會科學技術資料中心。

ISSN 1607-3509
GPN: 2005800003