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Prof. Horng-Tzer Yau, Advisor to the NSC's National Center for Theoretical Sciences, Wins "2000 MacArthur Grant"

Fig. 1 Professor Horng-Tzer Yau

When the MacArthur Foundation announced the winners of the 2000 MacArthur Grants in June, Professor Horng-Tzer Yau, a Taiwan native was on their list. Yau was the first person educated in Taiwan to win a prestigious MacArthur Grant. He will receive the US$500,000 grant over the next five years. Yau is a professor of mathematics at the Courant Institute of Mathematical Sciences, New York University. Yau is a member of the advisory committee of the NSC's National Center for Theoretical Sciences (NCTS). He is a visiting professor of NCTS sponsored by NSC and is a guest professor at National Chiao Tung University.

Also known as the "Genius Grants," the MacArthur Grants were established in 1981 and are considered the United States' highest interdisciplinary awards. In the eyes of the US academic world and the general public, the MacArthur Grants are an extremely lofty honor. The grant is awarded to a member of each professional area once a year on the average, and among the mathematicians so honored have been three Field Medal (the "Nobel Prize" of mathematics) winners, as well as Dr. A. Wiles—the first person to prove the 300-year-old Fermat's Theorem. Winners of MacArthur Grants are chosen through an extremely secretive review process from among of several individuals who have made outstanding contributions to their profession. The candidates' names are concealed throughout the selection process, which may take as long as several year. A candidate who has won does not know that fact until telephoned by the MacArthur Foundation. Selection standards include three key elements: Recipients must demonstrate notable originality, have outstanding past achievements, and possess even greater future promise and vision. Besides looking at recipients' past accomplishments and contributions, this award also emphasizes their potential and likelihood of future development. Moreover, a recipient's performance in his or her professional field must be widely acknowledged to be of the highest caliber.

Horng-Tzer Yau is an outstanding young mathematician who is currently 41 years of age. He received a B.S. from National Taiwan University (1981) and a Ph.D. from Princeton University (1987). He has received fellowships from the Sloan Foundation and Packard

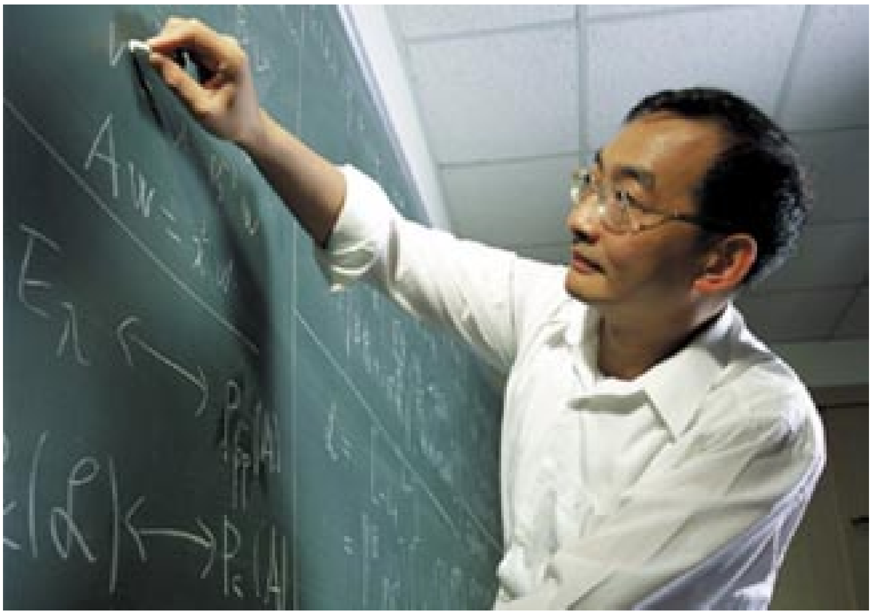

Fig. 2 Prof. Yau is a visiting profess or of the NSC's National Conter for Theoretical Sciences (NCTS).

Foundation (1991). The principal reason Yau has been awarded a MacArthur Grant is his profound application of mathematical theory to the elucidation of macroscopic physical processes. Yau proposed the novel concept of "relative entropy" in 1991 to deal with problems involving hydrodynamic limits by deriving descriptive formulae of fluid behavior (for example, Euler, Navier-Stokes) from the basic principles of statistics mechanisms. He has also researched the relationship between relative entropy and probability and mathematical analysis. Although the problems that Yau works on are rooted in physical phenomena, he has made important contributions to fundamental mathematics in several areas: probability theory, non-linear partial differential equations, spectral theory, and dynamical systems theory. Yau's current major research areas include (1) the extension of the relative entropy concept to quantum statistical dynamics and (2) stochastic and non-linear Schrodinger equations.

The National Nano Device Laboratories' Development Plan for Next Decade

Thanks to the groundwork laid by Taiwan's semicon ductor industry over the past quarter-century, an extensive industry infrastructure is now in place. And development is now proceeding faster than ever under the government's energetic policy of transforming Taiwan into an "island of science and technology." The National Nano Device Laboratory (NDL) is responsible for missions that include training the large numbers of engineers and technicians needed by the semiconductor industry and developing the advanced technologies that will serve as a basis for future industry development. In particular, NDL's research and training role has become even more important since the ITRI Electronics Institute's Submicron Project began spinning off companies. After the Executive Yuan approved the establishment of NDL in 1988, the decision was made to locate its facilities in the electronics and solid state physics building at National Chiao Tung University. Clean room facilities were completed and were put to use in 1992. After several years of hard work and extensive promotional efforts, the number of graduate students and professors using NDL's equipment has increased steadily, reaching 561 persons in 1999. While full utilization is now being made of NDL's facilities and personnel, it is obvious that NDL is ill-equipped to meet the future needs of industry and the academic community. But if NDL's area is doubled (to approximately 4,000 m^2 for the plant maintenance area, 1,200 m^2 for Class 1,000 clean rooms, 2,300 m^2 for Class 10,000 clean rooms, and 10,000 m^2 for research offices, outdoors landscaping, and parking space), it is projected that more than twice as many personnel can be trained as are today, and NDL's basic research and advanced technology development mission can be strengthened. This

Fig. 1 National Nano Device Laboratories

Fig. 2 The Class 10K Clean Roon.

Fig. 3 SEM Image of Resist of Electron-beam Direct-writing Lithography.

would reinforce NDL's role as an incubator of competent, innovative high-tech workers. In order to foster the continued growth of Taiwan's semiconductor industry in the new century, NDL plans to expand its laboratory facilities and has proposed a development plan for the next ten years. This ten-year plan provides for the development of sophisticated semiconductor technology and the training of expert engineers and technicians to meet the needs of industry in the new century.

It is projected that the global semiconductor industry will have the capability of producing 0.13-micron elements in 2002, 0.1-micron elements in 2005, and, most likely, 0.07-micron elements in 2010. In order to stay abreast of such rapid technological changes, NDL's ten-year plan will continue existing research on of micro-imaging modules, front-end modules, back-end modules, high-frequency elements, and analysis/measurement modules, and also establish micro-electro-mechanical systems technology, semiconductor instrument attestation, and semiconductor process consulting services. As far as micro-electro-mechanical R&D is concerned, NDL will initially use its existing equipment and resources to perform more joint research in microsystem development together with university teams, beginning with the establishment of fabrication and laboratory facilities for chip-based microsystems. In the mid-term NDL will support academic units also engaged in the development of microsystem elements. Farther in the future, NDL will forge alliances between academia and industry for the purpose of developing complete applications systems. Most semiconductor instruments and equipment currently being used in Taiwan are imported, which has hampered the holistic development of the local semiconductor industry. NDL therefore plans to cooperate extensively with makers of equipment in Taiwan and abroad, and ultimately achieve the goal of turning its clean room facilities into an instrument attestation center (type α or type β) for manufacturers. When the time comes, NDL will provide equipment upgrading consulting services and perform advanced technology R&D together with industry, training fresh cohorts of semiconductor process and equipment specialists.

In the face of stiff competition from the United States, Japan, China, Europe, and Asia, the greatest handicap to the continued development of Taiwan's semiconductor industry is a shortage of engineers and technicians. Because Taiwan can currently train only about 4,000 semiconductor specialists each year (this figure consists of graduates of university departments and graduate institutes of electronics, electrical machinery, computer science, physics, chemistry, and chemical engineering), but industry requires upwards of 6,000 new personnel annually, Taiwan's semiconductor industry will be short of roughly 20,000 persons within the next ten years. If this wasn't bad enough, recruiters from Singapore and Malaysia have been actively siphoning off Taiwan's manpower, aggravating the shortage of personnel. In contrast to Taiwan, China has a vast supply of human resources, and the Chinese authorities have been diligently acquiring technology and

Fig. 4 Mask Manufacturing with E-beam.

Fig. 5 Chemical Bath for Wet Cleaning and Etch.

Fig. 6 High Frequency Characterization of RF Devices.

funds from abroad in a full-scale effort to develop a semiconductor industry. The US government's recent decision to revoke the ban on exports of semiconductor equipment to China will allow the latter to acquire advanced technology as soon as the rest of the world. This is expected to give a tremendous boost to the Chinese semiconductor industry; it is forecast that China will supplant Malaysia as the world's leading semiconductor packaging center within three years (source: *China Times*, 12/23/99). In these circumstances, Taiwan must work even harder to train the human resources needed to stay ahead of competitors and secure an essential role in the world semiconductor industry. One of NDL's key missions is to train engineering personnel for the semiconductor industry. The NDL's ten-year plan provides for large expansions of its IC fabrication practicum training program, increasing the number of engineer and technician trainees to 300 from the current 30, and of IC fabrication technology training classes and semiconductor equipment internships, increasing the number of trainees to 1,500 from the current 700. The number of graduate students and professors able to use NDL's equipment will increase to 1,000 from the current 500. An average of 1,000 persons will receive full training at NDL each year, providing fresh new blood the semiconductor industry needs to cope with the challenges of the new century.

The experience of the past decade shows that NDL has played a pivotal role in fostering the local semiconductor industry's development and successful R&D. By engaging in joint research with universities and providing technical services, NDL has done much to raise the academic standards of semiconductor research in Taiwan. NDL has also made a great contribution by training the high-tech engineers and technicians needed to drive industrial progress.

In summary, the NDL foresees itself researching and developing submicron elements in collaboration with industr partners during the next decade. NDL will also conduct international academic exchanges, train large numbers of specialists, and lay the groundwork for the semiconductor industry's sgrowth in the 21st century.

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