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SCIENCE BULLETIN

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The National Science Council's Promotion of Sci-Tech Development: Basic Directions and Principles

The National Science Council (NSC) is a staff organization, operating under the Executive Yuan, that is specifically charged with matters related to science and technology. Its primary missions are to plan and carry out overall national sci-tech development, use the National Science Fund to support academic and basic scientific research, and develop the Science-based Industrial Park so as to promote the development of high-tech industries.

A solid foundation has been laid by the academic research and sci-tech development that has been actively supported by the NSC over the years. To cite fiscal year 1993 (July 1992-June 1993) as an example, a total of NT$11.98 billion was invested to support 6,612 research projects; there was participation by 9,363 persons, of whom 5,274 received research grants. The number of resulting research papers occupied 21st place in the Science Citation Index (SCI) and 11th place in the Engineering Index (EI), both showing substantial growth over past performance. The Hsinchu Science-based Industrial Park, for its part, recorded total revenues of NT$129.1 billion during the whole of 1993, for a growth of 48.13% over the year before.

Although the Republic of China's sci-tech development has established a preliminary foundation, we are still a substantial distance behind the advanced countries of Europe, America, and Japan in this regard. In planning for national academic research and sci-tech development, therefore, the NSC must focus primarily on areas and secondarily on points with the aim of achieving an overall upgrading of research standards and seeking breakthroughs on major points so as to reach first-rate international standards. Emphasis in the planning process will be on bottom-to-top academic discipline planning supported by top-to-bottom coordination and integration so as to give full expression to the efficient use of resources. In addition, given the limited resources available, it is especially necessary to select subjects in areas in which research achievements have already been made and then vigorously pursue development in those areas so as to shorten the gap between the ROC and the advanced countries. Regarding the overall planning targets and principles, they are designed to create a favorable environment for research and development so as to accelerate the speed of sci-tech development. The basic directions and principles of sci-tech development pursued by the NSC recently are described below:

I. The Efficient Distribution of Resources for the Achievement of Overall Effect

1. The distribution of research resources.

The development of any state-of-the-art technology is backed by basic science, and basic research and applied research complement each other; this is why the NSC has always placed heavy emphasis on basic research. The planned scientific research fund budget that the NSC originally submitted to the Executive Yuan for fiscal year 1995 (July 1994-June 1995) represented an increase of 11.1% over the previous year's budget, but the rate of increase approved by the Legislative Yuan was below 7%. For the promotion of academic and basic research, in principle the budget increase should not be below the overall growth rate(7%), while increases for natural science, mathematics, the humanities, and the social sciences will be granted in accordance with actual need. As for the work-study cooperation between industry and academe that everybody is so concerned about, the budget for this accounts for less than 10% of science development fund allocation, so that there is truly no trace of an "emphasis on application development and neglect of basic science," Also, in the detailed evaluation and review of the procurement of expensive instruments and medium-scale instruments, the research results of the applying organizations and the ease of integration of the various plans will have to be considered so as to economize on the limited resources available and support projects that encompass both basic and applied research.

2. Giving full effect to overall benefit.

In the past, most of the research projects proposed by academic organizations have been in the form of individual projects; group (or integrated) projects have been in the minority. To take 1993 as an example, applications based on research results exceeded 6,700 cases and applications for monographic studies topped 6,900. The amount of funding applied for in each study was in the range of only

NT$500,000 to NT$600,000, so the results that can be achieved are quite limited. To provide for the integration and the joint utilization of research resources, as well as for the interchange of research experiences and results, the NSC encourages research groups that have already made substantial achievements to carry out horizontal or vertical integration on their existing foundation in accordance with academic discipline plans, strategic-type key technology or policy-type focus projects (such as global change research that relates to human welfare), thereby forming research groups that can formulate three- to five-year integrated research projects with common targets. Encouragement measures offered in line with application for outside research or medium-scale instruments in accordance with need create a favorable research environment and facilitate a division of labor so as to achieve added results. For this reason integrated research projects do not affect appliactions for individual-type research projects, nor are they cause for concern about discrimination.

3. Establishing a fair evaluation system.

Since scientific research funding is limited, only through the operation of a fair evaluation system, together with such grant measures as the separation of subsidies and financial awards and a limitation on applications of one per year, can similar bases be established and enough time be provided for the work of evaluation, and can full expression be given to the basic spirit of academic grant so that outstanding researchers will be able to devote themselves to long-term research work instead of having funds allocated equally to everybody. The NSC is now in the process of studying the improvement of its evaluation system so that the establishment of standards for the selection of experts responsible for preliminary evaluation and re-evaluation, as well as for evaluation operations, can be carried out systematically and a system of evaluation appeal can be established. The evaluation system might be given some amount of flexibility because of differences in the various academic disciplines, but a follow-up auditing system will still have to be set up for the continuous monitoring of the fairness and impartiality of evaluation operations.

Precedence may exist in the advanced countries for the immediate evaluation of project applications whenever they are submitted, but the examples are all of large-scale projects for which only 30 or 40 applications per year are submitted. In consideration of the huge number of applications that are submitted in Taiwan every year, in the interest of fairness and impartiality it would be difficult to make any sudden change in the current system.

II. Policy Methods for Coping with Environmental Change

1. Encouraing the development of basic academic courses.

The number of students choosing such basic courses as mathematics, physics, chemistry, biology, and literature has contracted in recent years because of the influence of the employment orientation in academic advancement. Over the long term, this will do serious harm to the foundation for sci-tech development. To provide for the long-term rooting of a foundation for scientific development, the NSC hopes to coordinate in the near future with the Ministry of Education and work with it in formulating a program that can encourage gifted students to enter, or pursue advanced studies in, science and related fields. The NSC will support outstanding researchers in the area of basic science in carrying out long-term research work through more flexible evaluation methods.

In addition, the NSC will continue encouraging the spirit of participation in research by new people. Besides keeping a suitable ratio of expenses in various academic disciplines for application by new people, they will also be encouraged to participate in integrated research plans.

2. Continued promotin of academic-industrial cooperation projects.

The economy of the ROC is now at the turning point in the transition from a traditional society with a primary emphasis on agriculture to that of an industrially advanced country with a rich creative capability. The NSC will continue pursuing a strategy that encourages integrated group projects, choosing such strategic industrial sectors as precision machinery, sophisticated materials, wireless communications, computer systems, and biotechnology for the encouragement of academic-industrial cooperation projects that involve cooperative research among universities, academic research institutions, and private industries with R&D potential. These projects will include, for example, the development of computer systems, integrated circuits and system design, applied machinery design, electromechanical integration, and the application of gene transplantation in plants and animals, with the idea of providing for a full sharing and interchange of university know-how and research resources with the practical needs and experiences of industry so as to accelerate the upgrading of industry. In addition, in the past most of the results of research appeared in the form of theses, with results in the form of practical technology being relatively rare. Academic-industrial cooperation projects can nurture the ability of master's and doctoral candidates to handle practical problems, and provide for the timely supply of manpower needed by industry.

3. Motivating state-of-the-art technological research through a national laboratory

In recent years the NSC has set up such national laboratories as a Synchrotron Radiation Research Center, National Nano Device Laboratory, and National Center for High-performance Computing, with design and equipment standards that are of the first rank in the international arena. Universities, academic research institutions, and even the industrial sector will be encouraged to use these advanced facilities to break through research bottlenecks and pursue first-rate research standards and results. In addition, the National Space Program Office, through the implementation of its space program, will carry out the step-by-step establishment of an independent system engineering and integration capability for large-scale projects; also, through its procurement programs, it will bring in key technologies so as to instill a capability for the development of key parts and components in Taiwan, thereby building up a foundation for the space technology industry.

III. Coordinating Methods for Encouraging High-Tech Development

1. Promotion of international cooperation.

The scholars from the ROC who have gone abroad to study over the past 40 years have made outstanding achievements and have built up rich stores of working experience. In truth, these people are a major force in assisting the nation's development toward modernization. In addition to the active recruitment of outstanding scholars to return home for long- or short-term service, the networks of personal contacts that they have established are an important resource for the ROC in carrying out international high-tech cooperation. The NSC has recently been using the "Sino-American Sci-Tech Newsbriefs" published by the various Divisions of Science stationed in the United States to strengthen the establishment of domestic and overseas communication channels and networks as a basis for the development of international cooperation. Besides signing technical cooperation agreements with different countries, in the future the NSC will plan point-of-focus items of cooperation with various countries, striving to promote university-to-university and national laboratory-to-national laboratory cooperation between the ROC and other countries so as to provide for the international sharing of research resources and capabilities as well as the interchange of experiences. Besides this, domestic research teams with outstanding performances will be encouraged to participate actively in large-scale international cooperative projects; in addition to providing for cooperative interchange, this will establish the ROC's academic research position in the internaitonal sphere.

2. Upgrading the standards of academic journals.

Academic journals are vehicles for publicizing the results of academic research, and the level of their standards can reflect the quality and quantity of research results. To encourage outstanding academic journals of international standard, the NSC published the founding issue of the "Journal of Biomedical Science" in January 1994 for circulation throughout the world, thereby establishing an example for the commissioning a prominent foreign publishing company (S Kager of Switzerland) to publish a domestic academic publication. In addition, the NSC's Science and Technology Information Center has held four seminars for editors of academic journals in the field of science and technology with the aim of enhancing the standards of domestic academic journals; there are also plans to recommend outstanding journals for the collection of prominent international information institutions so as to expand the domain of academic interchange. The center has also brought together editors of journals in the fields of culture and the social sciences for seminars, and has listed journals in the fields of culture and social sciences among those eligible for grant aid.

3. Active promotion of administrative reform.

Sci-tech policies and strategies all depend on the operation of highly efficient administrative management for their implementation, and the major focus of all the improvement measures promoted recently by the NSC has been on the upgrading of service quality through administrative reform. For example, the separation of subsidies and financial awards allows the selection of the outstanding for incentives and the provision of assistance for those who come after, the establishment of an evaluation appeals system achieves fairness and justice, and step-by-step computerization upgrades efficiency and promotes the efficient division of labor in cooperation among the various units of the NSC — all of which measures rely for their success on the joint support and cooperation of all NSC personnel and others in the academic community. In addition, to upgrade the working willingness and efficiency of NSC personnel and to allow them to observe and learn in their work, from now on all brainpower-intensive work regarding planning, except for work that is commissioned out because of inadequate manpower, will be carried out by NSC personnel themselves to the extent possible, with experts and scholars being used to provide consultation and direction. In the future, the NSC will continue broadly accepting constructive suggestions and carrying out the work of administrative reform so as to provide the best service possible and promote a high level of sci-tech development in the ROC.

Update on Advance Discussions of the Government's Science Projects

Science and technology are regarded as one of the most important aspects of modern national development, and so the government allocates a considerable administrative budget every fiscal year to support them. In order to seek prudence and completeness of work for sci-tech developmental projects, the National Science Council (NSC) participates every year in advance discussions for important government scientific projects. Based on the government's annual fiscal pressure, the 1995 fiscal year (i.e., July 1994 to June 1995) budget allocation has been changed to a top to bottom distribution method, resulting in limitions on the expenditures for science and technology. Accordingly, the NSC is coordinating efforts by every ministry and department to first work out a "reasonable framework for comprehensive science and technology development priorities and appropriation needs; and establish links between the sci-tech development policy, priorities and budget," so as to avoid redundant investment and spur the close integration of upper-, mid, and lower-stream resources. It is also establishing fair and proper evaluation standards to effective utilize limited resources.

In order to attain the above-mentioned goals, the modified method for holding deliberations on FY 1996 (July 1995 to June 1996) sci-tech development involves first having all government agencies and ministries concerned coordinate efforts to draft a 1996 Outline Plan for Scientific and Technological Development based on the ROC Long-

and Mid-term Plan for Scientific and Technological Development and the National Six-Year Development Plan, as well as the current needs of such agencies and ministries, to strenuously seek close coordination between the budget and policy projects as well as the proper linkage between budget and results. Secondly, the method involves intensifying the distribution of labor and cooperation deliberation work, respecting professional division of labor, and having supervising ministries be in charge of initially reviewing to target compatibility between sci-tech projects and outline plans, the feasibility of projects, past results, project priorities and budgetary needs. Re-reviews will focus upon motions concerning the appropriateness of the results from the initial review, compatibility with upper-, mid and lower-stream projects in the field, avoiding duplication of efforts and setting priorities.

In order to strive for more penetrating reviews of cutting-edge and massive sci-tech projects, we hope to make use of the specialized talent of overseas specialists and scholars to help out in the review process. Accordingly, during the initial and re-review process, when necessary, we shall invite foreign specialist to assist in reviews. In addition, by the end of November 1994, the NSC will step up the number of combined coordination meetings its senior council members hold to propose, after the combined considerations of integrated sci-tech development, reasonable and beneficial percentage of growth and foundation by department meetings, hearings, the deputy head of DGBAS, and members of the legislature, a draft of a complete government plan for scientific and technological development, for submission to the Executive Yuan for approval and appropriation.

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Success in the Development of High-Quality Vacuum-Coating Technology

In 1980, PIDC (Precision Instrument Development Center) established a vacuum-coating laboratory based on the belief that optical coating elements of spare parts are the fundamentals of Electro-Optics Tech. In addition, our Electro-Optics industries were just about to expand to full blast. The aims of the laboratory were to manufacture machines for vacuum coating, to develop elements and methods of optical coating of various kinds, and to carry related software and hardware research into the vacuum-coating area.

In the early years of the laboratory, the vacuum industrial environment was still in the bud. At that time we had, based on the know-how we already had, developed and assembled vacuum-coating machines such as the Thermal-Resist Vapor Deposition Coater, E-Beam Multi-Layer Evaporator, Planar Magnetron Sputtering Coater, reference regulating systems and their peripherals. At the same time we developed technical methods of Thermal-Resist, E-Beam Multi-Layer Coating and Planar Magnetron Sputtering Tech. Some successful products were anti-reflection films, metallic films, high reflection films for laser, spectral films, various Filt-film and Ti_6Al_4V Hardness Film. Also we helped to train technicians in software and hardware for industrial employers.

Recently our vacuum industry has developed to a certain extent. Coating industries using traditional methods mainly export. They have created "the kingdom of sun glasses." Since then we have turned our attention to something more important, i.e., the development of modern coating technology and manufacture of high-quality coating elements. Important programs included research into the Ion-gun Sputter Coater, Assemble Sputtering Coater and its Ion Planing Coater, transparent conductive coating, Low-scattering Multi-Film, Resist Laser Damage Reflect Film, and multi-layer coatings of plastic glass and hardened films, which were all derived from the Cold Cathode Arc Plasma Deposition Machine, based on the needs of industrial and academic circles. We also invented techniques in manufacturing elements of the E-Beam Multi-Layer Evaporator and Ion Plating Coater. Our greatest breakthrough was solution of the difficulty of getting special refraction materials from natural sources without damaging their stabilized physics properties. We managed this by just partial adjustment of the coating monitoring system without modification of the rest of the traditional Dul E-Beam Multi-Layer Evaporator. It is by this technology that we may obtain any coating films of ideal refraction modulus, and is conducive to the realization of special ability film, which was originally improbable. It is also helpful in industrial use by decreasing layers of the coating with high optical quality.

Judging broadly from the existing trend we shall not only continue our development of coating elements and their techniques, but also establish our quality control system gradually by using instruments of our own combined with coating elements and mechanical ability tests. This will meet with more and more stringent coating quality regulations worldwide. We also wish to help industries with coating techniques and raise our coating levels to the international standard.

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