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SCHOOL ON PHYSIC IN INDUSTRY

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PHYSICS IN THE DEVELOPING COUNTRIES

presented by

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INTRODUCTION

The theme of today's session is concerned with the objective, the use and the prospects of physics to improve the industry and economy in developing countries. However an analysis of the relationship between physics research and technological innovation in the developed countries may help to understand the underlying complex and multi-faceted problems involved.

Physics has been a major and dominant contributor to technological innovation. Electronics and nuclear engineering have grown from the initial breakthrough of science in which physics played a major role. Right from the beginning physicists were in a strong position to influence the development and growth of these industries. Thus no one can argue the idea that the basic research in physics is as important or essential, without the constant generation of new ideas and knowledge, which is the prime function of physics, the technological advancement would soon ground to halt without these.

Totally undirected research work has been regarded as the oldest and the most noblest missions of basic science in the past. A scientist looks at the world and tries to explain what he sees and physics is regarded as an activity of essentially cultural and intellectural value. The physicists often regards themselves as members of intellectural elite and this sometimes lead to snobishness, where-by the applied research is despised as inferior.

However the boundaries and demarkation between fundamental or basic and applied research is obs-cure and rather philosophical. A great deal of government support research in developed country falls into mission orientated basic research. Therefore it can be said that fundamental research is not necessarily without economic motivations though the financial return may be uncertain.

The recent world wide deteriorating economic recession and rapid growth of high technology based industries have led to increasing interest in applied or mission orientated basic research in both developing and developed countries. However the problems involved in developing country are very different from in developed countries, in the former the orientation of development is toward the Western type of industrialization as late-commers, and are endeavouring to catch up with the latest technology, whereas in the developed countries they are more concerned with increased productivity, energy saving and pollution control.

PHSYSICS IN INDUSTRY

Historically physics research as established a weak link with industry, in a sense that the development of physics has worked against it. As soon as the fundamental breakthrough has been made a new discipline was created willingly or unwillingly. The evolution of electrocal amd electronics, aeronautics, nuclear and telecommunication industry are examples of the transfer of physics to industry.

The transistor is the classic example of a science based technological innovation. The idea for a solid state amplifier emerged in the early process of investigating the elctronic properties of insulating crystals; thus the idea energed from physics at a stage when the state of knowledge was quite inadequate for the transformation of the idea into reality. At the same time the technology of vacuum technology was quite well developed and was coping adequately with the tasks set to electronics.

Solid state phsyics had made steady progress throughout the 1920's and 1930's as the results of quantum mechanics that were gradually applied to solids. Eventually the scientific base for the transistor emerged from Bell Laboratories as a result of the corporation between science and engineering. The most important contributions of engineering were probabley manufacturing techniques which enabled the transistor to be made and furthermore economically feasible.

Thus the physicist invented new ways constructing transistors and discovered more about the behaviour of carriers in semiconductors in the early days. The metallurgist discovered new ways of purification and growing better quality crystals, while the engineer devised new methods of manufacturing transistors, and new ways of using the new devices in the electronic circuits. The corporation between physicists, engineers and also scientific and engineering experts over a wide field made a new solid state device.

The innovation link between physics and engineering becomes more pronounced in microelectronics. The physicist is now taking a bit of a back-seat and the most important people have become computer experts and computor architects. Production yield is an economically vital parameter which depends on high quality engineering, good scientific equipments and skilled manpower. The art and science of photoresist and photolithography, in which polymer chemistry plays an important role, determines the definition of microcircuits and their feature size, speed of operation and density of surface use. Similarly the packaging of integrated circuits into large circuit element depends on orgainic substrates and packaging materials.

To obtain masks for photolithography with the best difinition and smallest feature size as well as direct computer control of manufacturing and high production efficiency an electron beam is used. Electron optics owes its high degree of development to electron microscopes. Electron sensitive photoresist had to be developed by a polymer chemist. The high vacuum techniques also have a long history of development in which physics and engineering were linked together. This is a typical example of scientific instrument is becomming production tools.

At the present we saw many important technological advances, ie; microchips, fibre glass, new ceramics and polymer. However it is less apparent that physics is then continuing to make contributions to these advancements it should be. The more traditional basic and exploratory research for physicists were limited as the high technology based industry begun to mature and were no longer needed our service and therefore they declined to accept our service. As a result many new Ph.D's and graduates ended up in positions which had not been occupied previously by physicists. Naturally they feel that they are misemployed and were bound to have an unfavourable impression of physics.

Will there be more or less demand of physics and physicist in the future? What kind of service can physics offer to industry is one of our objectives of our gethering "PHYSICS IN INDUSTRY".

Industry needs a continuing source of new ideas and highly trained personnel in the new technology. Equally university physicists need to maintain link with the real world. It is time for university physicists to recognize the areas of prospective major industrial development by asking those in industry where they see the problems are going to be and whether it is worthwhile getting involved, especially in the field of high technology.

MANPOWER SHORTAGE IN DEVELOPING COUNTRIES

The shortage of skilled personnel scientists and engineers is one of the limiting factors in developing countries. The shortage happens because university teaching is tailored to the industrialized country. They start to feel that their trainning is too specialized and advanced for the present needs of their own country and cannot look forward to a career in their own country especially for the scientist including the physicist. The lack of confidence in their professional career because of the absence and shortage of equipments,facilities and above all leadership. Developed countries have provided the opportunity to train personnel from developing countries, but have failed to encourage them to return home.

KOREAN STRATEGY FOR THE PROMOTION OF SCIENCE AND TECHNOLOGY

The basic objective has been to upgrade science and technology, and improve their application to economic growth. The Ministry of Science and Technology (MOST) enacted sevral laws concerning the promotion of science and technology and was in charge of formulating and implementing plans as an integral part of the nation's economic growth.

The Korean Institute of Science and Technology (KIST) was founded in 1966 by Dr. Hyung Sup Choi as a multidisciplinary industrail research institute to bolster the growing Korean industry, particulary in key areas of strategic importance to the economic development plans.

A comprehensive survey of the Korean industry was made before the undertook contract work by 80 experts f 8 months and the survey helped to identify the problems facing them and selecting key areas of primary importance. Such a survey was carried out periodically to meet ever-changing demands in industry and up-grading research output to be competative to foreign technology. The multidisciplinary approach was emphasized and encouraged from the foundation of the institute to loosen the rigid demarkation between different disciplinaries. The selection of strategic areas led to important decisions concerning the staff recruitment mostly from abroad by offering generous and competative salary and benefits to their previous employment including resettlement and transportation allowances.

As Korean industry grew the diversification and up-grading of technology involved in the division or sonetimes in laboratory was required. The Institutes of Machinery and Metals, Shipbuilding, Chemistry, Standards and Electronics spun off from the KIST. These new institutes inherited the technology accummulated as well as working management with the philosophy which too often is missing in a new institute.

The Korea Advanced Institute of Science (KAIS) was established in 1971 as an autonomous postgraduate institute by MOST to train high calibre research and development personnel to meet the demand of growing industries of all sectors. The faculty members were recruited carefully from abroad, and were requested to have several publications in the internationally renowned journals with established research and teaching experiences. The recruitment of students was highly competetive, once the students are admitted the best possible benefits Korea can offord, are provided for 2 years for M Sc students and another 3 more years for Ph D students, including full scholarship, exemption from military service and job gurantee. The Ph D candidates are requested to publish a paper from their Ph D theses in an internationally renowned journal to prove their standard of work before their thesis submission.
The graduates of KAIS are playing key roles in every sector of the Korean industries including VLSI, optical fibres, nuclear power plants, shipbuilding, steel mills and chemical plants, etc.

The integration of KIST and KAIS took place and the Korea Advanced Institute of Science and Technology(KAIST) was foundedin 1981. The integration was aimed to economize research by pooling manpower and facilities as well as strengthening further postraduate education. A new undergraduate's institute (KIT) has recruited gifted students with an average IQ of 130 to educate a new breed of scientist equiped with a multidisciplinary background without departmental segregation.

According to a new five year plan, 1982 - 1986, the investment for science and technology will be increased to 2 of the gross national income by 1986 from 0.89 in 1981. It is envisaged that the self reliance of key technologies will hopefully be achieved by 1990. Currently the MOST is formulating a master plan to build a comprehensive science town "Technopolice" at Taedok, and construction work has started in 1984 and it is scheduled to be completed by 1988.

THE KOREAN EXPERIENCE

The results of scientific and engineering research are accessible to anybody. However technology is not readily accessible because firstly the technology must be learnt by practice and secondly the technology is protected by patents. Furthermore the accessible technology is some times obsolete and available only between endorsed countries in fear of a boomerang effect in trading.

The latest technology in the developed countries, regardless of their original nationality, can bring down the production cost and enhance consumer satisfaction. The modern intercontinental transportation makes the whole world virtually one market and the goods produced cheaply in developed country with advanced technology compete with the similar goods produced in developing country with cheap labour cost, whose productivity is low and quality is inferior. These are the hardships in developing countries we have to put up with in the past and present, and may be in the future.

A relatively small number of scientists were emplyed in Korean industry due to combined reasons;

1. inadquacy of training
2. industry's unwillingness to employ them
3. top management's incomprehension of the technology involved

For instance no physicist was consulted when one electronic firm set up the production system of VLSI, and complete production facilities were brought in and engineers and technicians were trained by the suppliers of the plant. The engineers engaged in the production of VLSI were electronics graduates who knew little about silicon wafers, oxidation, photoresist, lithography and etching, hence the production yield was too low to compete in the international market. However this firm produced 30,000 chips/month in 1983 and hope to increase production to 150,000 chip/month by 1987.

There has been a radical change in recent years since the management realized the difficulties of importing high technology based industries due to the reluctande of developed countries to supply new technology.