ROLE OF PHYSICS IN ENGINEERING EDUCATION

★ DR. A. P. RAO

ABSTRACT

This short paper initially deals with the explanation of the science as the attempt to investigate and understand the mystery of the nature as perceived by our senses and experience in replicable manner that corresponds to a logically uniform system of thought and engineering as the application of science in economically acceptable form. And, therefore, basic sciences have their own importance in the broad spectra of engineering education system. The histroy of physics and its relation with engineering have been discussed. Then our present engineering education system and the status provided to the subject physics have been discussed. The need is to frame the syllabus in proper way for various engineering courses with logical step-up. The author stresses on a multi-tier changes in the structure of current curricula to start constructive interaction between physicist and engineers of the future, right from degree level. From author's point of view, the coordination among physicists, engineers and educationists shall help the engineering students to go for higher studies which positively affect our technoloigical development. Then,. the examples of material engineering, optoelectronics, cryogenics and superconductivity have been described and it is shown that in engineering education, the coordination between physicist and engineers is a must which results in a faster rate of development in technology for the betterment of mankind.

Science is the attempt to investigate and understand the mystery of the nature as perceived by our sense and experience in a replicable manner that corresponds to a logically uniform system of thought. According to E. Friedenberg "only science can hope to keep technology in some sort of moral order". Engineering may be defined as the field in which scientific and technological development is to approach the 'wholeness' in the true sense of the term. We just can't neglect the social sciences because if there is any technological advance without any accompanying social advance, there is, alsmost inevitably, an increase in human misery. Therefore, all basic sciences have their own importance in the broad spectra of engineering education.

The roots of Physics, as of all sciences, engineering and technology are found in the first period of Greek philosophy in the Sixth Century B.C. in a culture in which science, philosophy and religion did not have seperate

Asst. Professor of applied Physics B. N. College of Engineering,
PUSAD, (M. S.) 445215

existance. The term physics is derived from Greek word 'Physis' and meant originally, the endeavour of seeing the essential nature of all things. Later on, the studies were confined to physical things only. Physics, as any other branch of basic sciences, attempts to explore the ways of working of nature and presents the mankind, the new facts, their interpretation in the form of theories and a host of physical discoveries. And, it is the engineer who has to use these advances in science for the betterment of life. This is feasilble only with the keen interaction between physicists and engineers. Many physical laws may not exist in the similar form forever. Understanding the vastness and rapid development of the stream the great scientist Heisenberg had once said - "It is very difficult to experiment with quanta, one has to experience it". This shows how challenging job is before the physicists and engineers ! And thus, one can also understand how competent an engineer is required to be, to use such rapid developments in the basic sciences for the society. Therefore, physics is to be given its due importance since it is one of the corner stones of the modern engineering sciences.

Ever since the time of independance, our country has followed the west in several areas without adapting the policies to our environment and needs; and unfortunately, the field of education is one of such areas ! Ironically, our current system of engineering education, for most of its part, except for some premier institutes, has retained the old British structure. Whereas, in the mean time, Britain itself has brought radical changes in its eductional systems. By and large, we have been reluctant to realise the fact that if we want to be totally self-reliant in the field of technology and if we have to keep pace with the rest of the world, the basic sciences and their interaction with the applied sciences i.e. engineering, must improve remarkably, so much so that, every small discovery made by physicist and other basic scientists are to be regularly noticed and examined by the engineers and technologists to see the viability of developing some new applications.

In the light of above discussion, it may be advisable to bring multi-tier changes in the structure of current curricula of basic and engineering sciences that could enhance the current level of science-engineering interaction which will go a long way in making scientists feel the need of engineers and making engineers aware of the recent developments in the basic sciences that could be utilized for building-up new technology.

Our society has considered engineering education more as a tool of money making and less as a means to serve the mankind. This may be due to the glamour associated with the field. When we observe the engineering education in India, we find that a small percentage of engineering graduates go for Master's degree course and only a negligible percentage of Master's degree holders go for higher studies and research. In our country, higher studies are not opted by most of engineering graduates. There my be many reasons for the same. Most of the engineers are utilized for routine engineering work like maintenance and production in our country. Simultane-

ously, it may be observed that many practising engineers do not motivate themselves to continuously update their knowledge which adversely affects our technological development. Lack of proper coordination between physicists, engineers and educationists within the framework of the university curricula may be the cause for this.

A survey of any international scientific research journal of pure or applied field indicates that engineers, technologists and physicists have to essentilly coordinate their efforts for the success of any project. They have to deal with the needs of new era of development techniques as a team. It shows that the constructive interaction between physicist and an engineer is very important. It may be observed that this does not exist at lower level of engineering education in India. The reasons may be many ! The adverse effect of this fact reflects in our technoloical development. Our policy makers are yet to realise that the subject like Physics can not be kept away even at lower degree level. The understanding and interaction between physicists and engineers does exist, surprisingly, at higher level of education, research and development. If we could do the same right from the base of engineering education, there would be a drastic change in technological development of the country. From the harmony point of view between the two, syllabus framing of various subjects has its own importance. Syllabus framing should be entrusted to only the competent people by the authorities. Structure and contents of the syllabi at the undergraduate level also affect the higher studies and applications to be carried out by our engineers. A high level hierarchical coordination and monitoring committee with enough knowledge and experience, must be appointed at the universtities. The coordination between acadamicians from Physics and engineering fields should be followed by discussion about fundamental requirements, extensions, replacements and expansions to be carried out in a particular engineering field. Curricula must be designed in such a way that there be sufficient scope for introducing the students to the recent advances in their chosen and related fields in the 'Learn-it-if-you-care' manner. This shall help to understand and later-on to use them by our engineers effectively to move along with the developed countries.

In the following section the role and importnce of Physics in various fields of engineering and technology to reach a higher level of understanding is discussed in brief.

In the field of material technology, development of base material is very important. This is specially true for the engineers working in industries of aircraft production, space projects, computer manufacture and nuclear power engineering. Materials with precise electrical, magnetic, thermal, optical and chemical properties are demanded in industries. Unless there is co-ordination between material scientist and technologists, faster rate of progress may not be possible. For example, the progress in selection of material and design of new materials with more precision by metallurgists has been possible because of the study of properties of electron and then materialising the idea in the form of

electron microscope. Recently, study of lower dimensional carrier system has proved to be of great importance from technological point of view. The ability to grow modulated semiconductor structure shall be of great help to modify the material parameters. The study of these materials shall result in improved optical and transport property materials. These shall be valuable for quantum well wires and boxes in which carrier motion is supposd to be quantized in two dimentions only. This will further be useful for the development of high speed semiconductor devices.

Optoelectronics has shown its wide scope in engineering field. It is used for millimeter wave radio telescope, image processing, night vision system etc. For such applications, the fruits of the basic research is required to be supported by physicist in coordination with the engineers. For example, study of infra red sensitive powder materials & colour centres are to be used for design and development of new low cost optoelectronics devices. Spectroscopic techniques are used during development of optoelectronic materials for the fabrication of high power solid state lasers. The roll of roughness of the surface in optical fabrication and testing has been studied by physicists which is further used by engineers in radio communication, radio astronomy etc.

Cryogenic engineering is again an advanced field which has remarkable contribution in the R & D activities in various fields like metallurgy, aviation, fuel science, space science, metal fabrication & electronics. The study of superconductivity of amorphous metals, thermal expansion of magnetic materials at low temperture, kinetic theory of A-15 super-conductors are a few portions of cryogenics field which are being handled by physicists. In the present day situation, it is felt that the problem which the country is facing in the field of cryogenics could have been avoided if we had exchange of organised stimulating thoughts for utilization of tremendous potential of cryogenics in Physics and other disciplines a little earlier. Therefore, it may be the right time to introduce cryogenics in the curriculum of engineering degree course by utilizing the capacity of physicists in order to use the wide applicability of this multidimentional subject in production, maintainance and measurement at low temperature in future.

Another good exmple of coordination among physicists and engineers (of-course along with many experts from related areas) is the field of application of superconductivity. The superconducting properties of materials of various class have been studied by scientists which may be useful inAccelerator and wire fabrication technology, power and energy application and computer & device manufacturing applications. The electrical properties of high temperature superonductor (HTSC) materials inspiring physicists, seem to be tightly linked with their mechanical properties disappointing practice workers. As in the case of A-15 superconductors, the solution of the problem of manufacturing HTSC wires and solenoids with them lies on the path of composite materials, this path requiring titanic efforts of process engineers. The HTSC materials to be used for

technical purpose requires strength, flexibility, avoiding crack and fitting to other materials in order to fabricate useful equipmets. The high amperage conductors made of HTSC have direct importance in energy storage and generators. The researchers have been studying the properties and trying to develop new materials which can be used high current long length wires and tapes to be used in transmission lines or distribution network. Now industry has been waiting for a new conductor design with stronger mechanical properties for these applications. Further the study of HTSC thin films offer the promise for major progress to reduce the volume and weight of advanced microwave system. These microwave devices can meet the requirement for ultra-multichannel communication for use on earth and in space. Very recently physicists have discovered that there are intergrannular contacts of an order of coherent lenght in size in HTSC ceramics whcih enables a successful development of one contact rf-SQUID which further can be applicable for magnetic cardiography and sensitive galvanometry.

The stage at wich we have reached in developing and using superconductirs in recent years is remarkable and is a result of combined efforts of physicists, engineers and experts of all disciplines. The society has been waiting for the time when it shall use this technology in its dya-to-day life.

All said and done, it may be stated that in this era of science and technology, Physics has its own place of prominance and it is an essential element of the world of engineering. Therefore, if we have to be at the top and if we have to remain there for all the time, we must make fresh beginning now-by forging an effective alliance among physicists, engineers and engineering educationsists ! This, and only this, can save us from taking a back seat in the years to come.

The author expresses his thankfulness to Prof. Rahul Banerjee, computer engineering department, B. N. College of Engineering, Pusad for various discussions and sugestions.

★