# EXCELLENCE IN ENGINEERING AND CARDINAL DIMENSIONS OF ENGINEERING

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***Abstract :*** *The education system should develop the ability of self learning in the common fields of activities needed in applying scientific tools to problems that require the use of natural resources for the convenience of humankind. Engineers are required to have the ability to communicate with others, and are expected to find economical, practical, durable, innovative, aesthetic, safe and clean solutions to human needs. Radical changes are necessary in order to be able to assign projects that can provide the proper environment for the students to develop the abilities to solve real problems. Students enrolled in special programmes should be encouraged to make use of computer centres, laboratories and libraries, and evaluated by a special committee headed by a tutor. Since the main function of science is to observe, discover and formulate the laws of nature, the approach required to achieve excellence in science is much the same anywhere in the world; except for differences in infrastructural facilities and in the working environment, scientific work is much the same anywhere in the world. Educating engineering students requires more than the transfer of the knowledge and skills needed by the profession. Engineering is indeed a way of life that must be experienced through role model examples. Many educators in the field of engineering have contributed in enhancing the quality of the profession. A new construct for systemic change in baccalaureate engineering education is suggested in terms of taxonomy of intellectual components connected holistically with a core focus on developing human potential, as opposed to the present system in which students are passed serially through course filters.*

***Key words :*** *Behavioural instincts, Quality assurance, Engineering excellence, Building character*

## Introduction

The main function of technology is to deal with the means of application of science. Its scientific content is universal but its application can get conditioned by the environment in which it has to be applied and so as to achieve excellence in technology it could become location specific in many cases.

The main function of engineering is to convert the resource available into actual goods and services needed by the society giving due weight age to all the parameters involved whether they be in scientific, technological ,economic, social, ethical, management or even political realms by properly synthesizing them all towards a realistic and optimal solution in each case. Thus, it is clear that, in order to succeed and reach excellence in engineering, several parameters have to be looked at together and synthesized and optimized. Therefore, the parameters involved in excellence in engineering should not be confused with those of science and technology as such although there would naturally be many commonalities amongst them, and in fact, even between leadership qualities required for others in the society and those who have embraced engineering as their profession.

The education system should:

- Improve the ability to question and to seek answers.
- Sharpen the vision of the details.
- Refine the mind for greater sophistication at interpreting data and encourage independent thinking.

## Cardinal Parameters or Dimensions of Engineering

The cardinal dimensions to be looked into for Excellence in Engineering can be explained with the

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help of figure 1 and X, Y, Z axes therein,

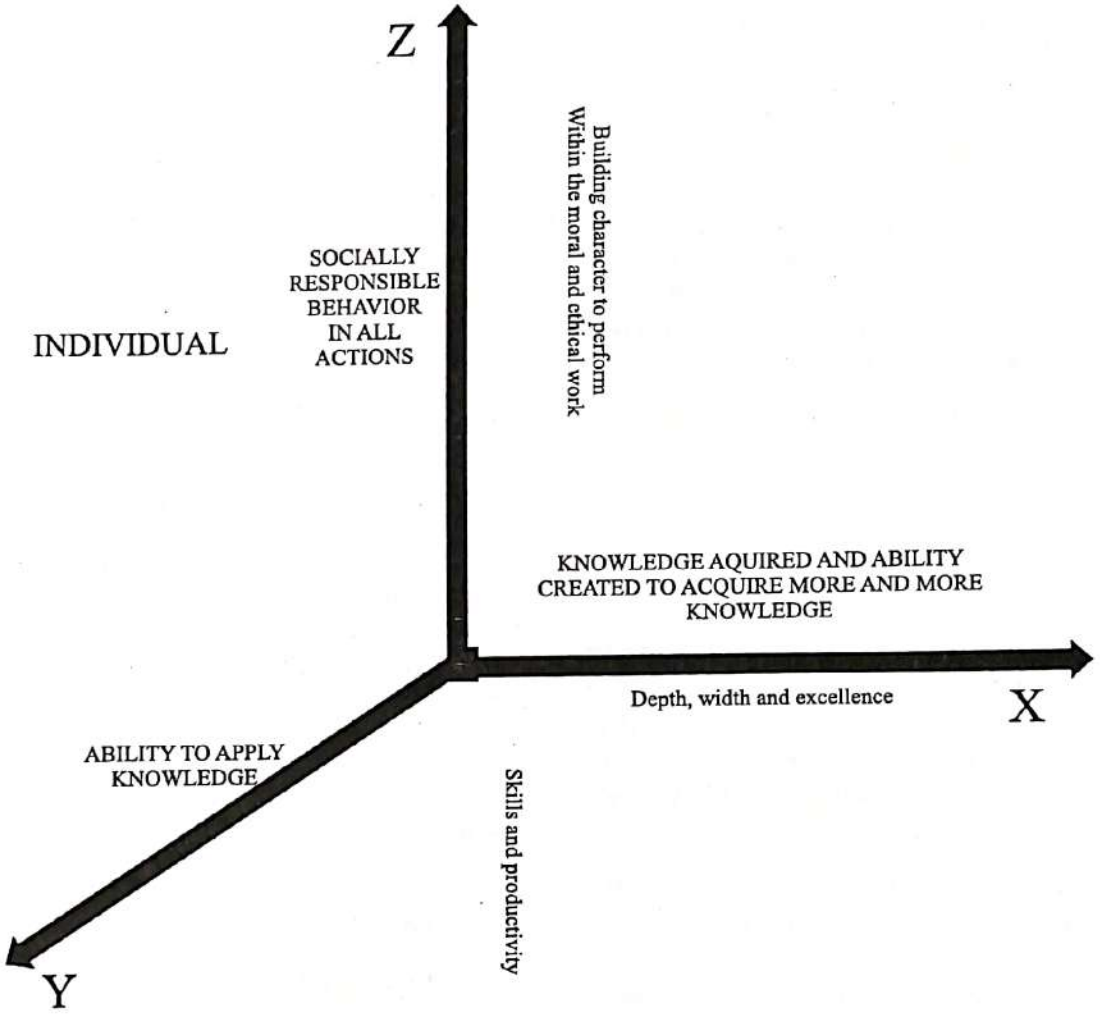
X : Knowledge acquired by the engineer at any given stage and his/ her ability to acquire more and more knowledge. The depth and width of these and the level of excellence reached constitute the measure of this dimension.

Y : Ability of the engineer to apply his/ her knowledge for the progress and good of the society.

The skills acquired, the productivity of application of the skills knowledge to any given issue in service of the society constitute the measure for this dimension.

Z : Behavioural instincts and habits so that all actions of the engineer are within the frame work of socially responsible conduct of affairs .The conduct and character of the engineer as predicted constitute the measure for this dimension; Indian heritage is fortunately so rich in this, if these are put into real practice in all the day to day affairs excellence can automatically be reached.

**Figure 1: Basic Dimensions of Excellence in Engineering**




## Sustainable Regime Essential for Engineering Excellence

The ultimate goal of all development is expected to be the improvement in the quality of life in society, how the concept of sustain ability can be built into this goal is not yet precisely understood.

The task of engineering is to convert available resources into goods and services needed by the society for improving its quality of life. Therefore, to say that all natural resources should be preserved as they are, undisturbed, is neither a practical proposition nor an engineering reality. Successful development would many times involve some disturbances in our environment and, therefore, it is not appropriate to assume that sustainable development is synonymous with zero degradation; therefore sustainable regime has to be understood as that regime where the endeavour is to minimize the rate of degradation and to ensure that however small

a degradation that does occur is made up in the best acceptable form and as fast as possible with the aid of rapid advances in science, technology and engineering. This applies equally to climate change issues. The concept of sustainable regime is not new; there are many examples of men of wisdom practicing it over centuries. But, a more analytical methodological approach started with the world commission on Environment and Development commonly known as the Bruntland commission through its seminal 1987 Report. Our Commission Future brought into common use the term Sustainable Development defining it as development towards meeting the needs of present generation without compromising the needs of the future generations. Since then the term Sustainable Development has been widely used, sometimes misused, and perhaps even abused on occasions.

What is important for achieving excellence is to ensure that all engineering activities are carried out in a sustainable regime; that regime which results in sustainable development. This would also very certainly cover the important issues relating to climate change.

**Quality assurance Essential for Engineering Excellence**

The internationally accepted definition of Quality is:

*Totality of features and characteristics of an entity (A product or service) that bears on its ability to satisfy the stated or implied needs.*

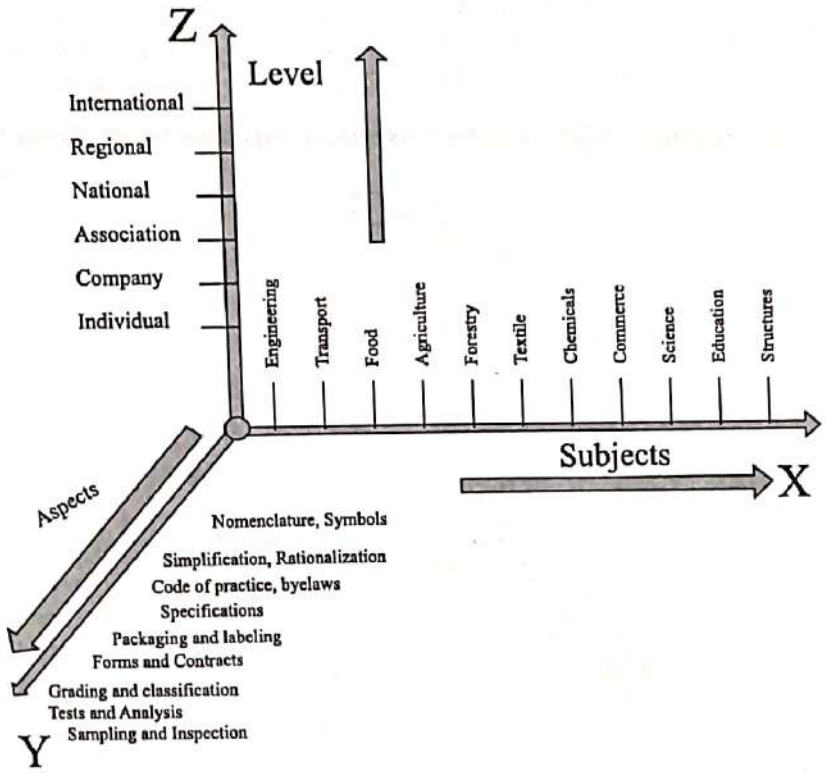
The stated or implied needs are those derived by optimizing the above stated three dimensions and above stated sustainability along with consideration of equity worked out from the socio-techno-economic considerations. This is precisely what is sought to be achieved through the process of standardization especially at the national and regional levels; the thus evolved national standards provide the basis of assessment of quality.

There is a general feeling in the public mind that standards mean some rules of guidelines and that standards formulation is a routine simple job that almost any reasonably educated person or group of persons with a mandate or authority can do. It is not so. There is a lot of philosophical thinking, socio-techno-economic considerations and even political parameters in addition to scientific, technological and engineering considerations. It is only when standards formulated are appropriate, people get the anticipated or expected goods and services.

This can be briefly explained through the aid of Figure 2 and Figure 3.

In Figure 2, the three dimensions conceived by Dr. Lal C. Verman and accepted internationally are subject, aspect and level.

**Figure 2 : The three dimensions conceived by Dr. Lal C. Verman and accepted internationally are subject, aspect and level**



In Figure 3, conceived by the author, the three dimensions are technology orientation, transfer interface and system status.

Quality compliance is achieved through the process of Quality assurance. There are a variety of processes to achieve quality which are practiced at different levels in different situations by different agencies and authorities. These can be grouped broadly into the following groups.

***Policing Quality:***

Ensuring quality of the final product or service by involving a third party to provide a certification after inspection and testing thus bringing a new dimension of confidence building and fairness.

***Fostering Quality:***

Ensuring quality of the final product or service by attending not only to the final product or service but also to the various stages from almost the beginning such as in the recognised certification making schemes.

***Growing Quality:***

Ensuring quality of the final product or service by ensuring that in the various structure of management of an activity or enterprise quality consciousness pervades and that quality indeed becomes a way of life in the whole system. There are many modern methods, approaches , and systems to achieve this goal.

It is the view of many experts, that a judicious combination of the last two systems stated above yields the best results in practice. In this frame work any of the modern methods such as simple arithmetical, stochastic, six sigma, and so on, as appropriate, can be used.

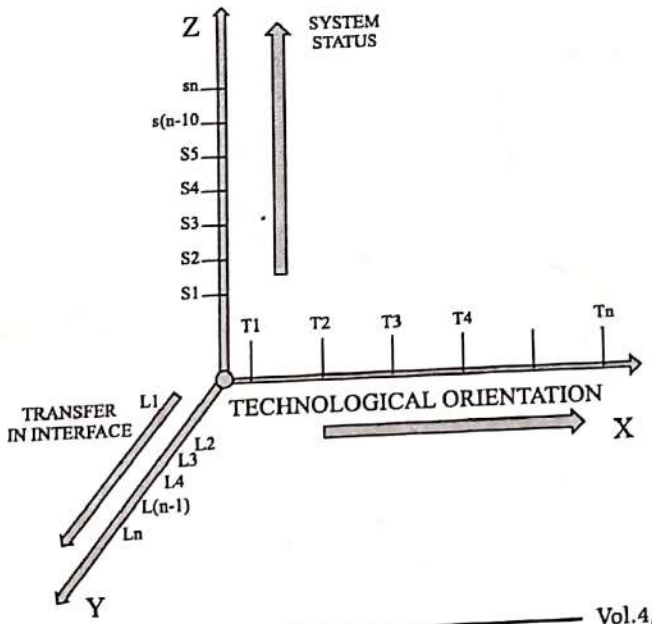
## EDUCATION FOR ENGINEERING EXCELLENCE

Everything stated above can be achieved through only through proper education. Whilst education has to be of real value, one will have to cover from pre-KG level to post -doctoral level. Here again to avoid elaboration only a few aspects can be very briefly considered.

It needs hardly any emphasis to state that proper engineering education is the very foundation for meeting the three dimensions of engineering stated above, for ensuring that engineering activities always remain within the sustainable regime, and for assuring quality in a global environment, and thus deliver what is expected of excellence in engineering.

In many engineering educational institutions the entire academic programme comprises of only undergraduate courses without any linkage with research, design, and industrial and engineering activities in practice in the field .It is now well understood that an undergraduate education is better in an environment of post-graduate programme. Similarly, both the undergraduate and post graduate programmes get better toned up when these are pursued in an industrial environment where engineering is practiced in the field or in a research environment such as those covered by doctoral and post-doctoral programmes; it would be even better if these post-graduate programmes and research programmes are also pursued in an environment of applied research, design, consultancy, and field practices in industry or agricultural engineering.

**Figure 3: Visva Standardization Space concept Identifying Standards from functional view point**



Having stated the above broad principles, any further attempt to elaborate on education in engineering , would only be repetition of what many stalwarts in technical education have written and spoken in plenty. It would suffice here to touch upon a few matters relating to accreditation. If the parameters on which accreditation is done are sound, then the institution or the programme accredited is sound.

For the purpose of accreditation, technical education can be evaluated or assessed programme-wise or institution-wise or for a combination of both these. Whichever of these is adopted in the accreditation process, assessment of the ability of the programme or of the institution to maximise inculcation of the three basic dimensions elaborated earlier through the Figure 1 is fundamental.

These three dimensions are:

(a) Depth, Width and Excellence of Knowledge,

(b) Skills and productivity in Application of that Knowledge and

(c) Ability and self-motivation to do all these within the moral and ethical frame work.

It is not the intention to elaborate here the details of the process of accreditation to achieve these; it is sufficient to point out that the accreditation processes, when properly designed and implemented, would help in improving all aspects of education because,

(I) The institutions would know that their programmes or institutional infrastructures and systems are independently judged in a way it would lead to their continuous improvement.

(II) Those students would know that relative standing their learning in the institution would be which would enable them to decide their preferences.

(III) Those who come out of their portal of the institution know the professional and market value of their qualification and also the extent of their acceptability in the professional world.

(IV) The employers would know their new employees levels of attainment, knowledge and skills.

(V) Those who fund, and the society at large, would know to what extent the funds provided are being utilized towards acceptable/ expected education.

Educating engineering students requires more than the transfer of the knowledge and skills needed by the profession. Engineering is indeed a way of life that must be experienced through role model examples. Many educators in the field of engineering have contributed in enhancing the quality of the profession.

## CONCLUSION

If our country has to progress, and if our society has to provide better and happier living for our people, we would aim at excellence in whatever we do. We, who have chosen to pursue our profession as academicians, should therefore strive for achieving Excellence in Engineering. However, creating an atmosphere that enhances the enthusiasm of the students to work for the intrinsic motivation of being successful can prevent misconduct.

Some of the measures include Praising outstanding performance and warning in case of failure should enhance group dynamics, Genuine interest in changes in attitude should help in the disclosure of intimate issues, Implementing a generous bonus system should motivate doing extra work, Immediate advice should overcome the feeling of panic and thus help in creating an appropriate atmosphere .

There is, therefore, every reason to place renewed emphasis on the moral and cultural dimensions of education, enabling each person to grasp the individuality of other people and to understand the world's erratic progression towards a certain unity; but this process must begin with self-understanding through an inner voyage whose milestones are knowledge, meditation and the practice of self-criticism.

There is unfortunately the temptation on the side of the student to indulge in unethical practices, hoping that the instructors will not be aware of the situation. However, creating an atmosphere that enhances the enthusiasm of the students to work for the intrinsic motivation of being successful can prevent misconduct.

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