Ingenuity in Curriculum of Engineering Programs in India

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***Abstract* -- To strengthen the profession of engineering, modifications need to be made in the curriculum, with more emphasis on experimentation and subjects dealing with practical applications. The young students must gain concepts in a more constructive fashion and broaden their thinking. We must prepare true design engineers and ensure that India takes part in manufacturing process in the globalization era. We must improve the objective perception of young potentials, which goes well with broadening their mind-space by reducing the aggressive approaches. The curriculum must be modified in the light of emerging areas of Neuro-psycho-physiology and the lateralization of the hemispheres of the brain. Then only we can truly say —Mad in India" products of young minds.**

Keywords–Curriculum Design, Objective perception, Global problems, Causality, creative design, neuro-psycho-physiology

1.1 BACKGROUND

—The best way to predict the future is to create it"—Peter Ducker.

Man is bestowed with knowledge tools which are used for creative thinking and innovations, to make life more smooth going. He has been created by creator for furthering the creative refinement of tools.

In fact man is in the making. If we trace the history from the Neanderthal man, human being has developed tools for earning bread and butter. Man has tried to refine and produce more sophisticated tools to make his living more comfortable & environment friendly. In a way tremendous effort, harmonious team work and improved skills have gone in producing sophisticated instruments. Sequentially efforts also have gone to create a focus in developing concentration, by the education system. Though several intellectuals have tried to improve education system & curriculum development at various stages, there has been some difficulties in delivering the tools to youngsters and in the expected outcomes.

National Academy of Engineering [1], [2] made a survey and summed up the contributions to be made by human creativity and the issues need to be resolved.

Some of the great achievements / creations are due to industrial revolution, design of machines, improved systems and tools. In a way engineering has revolutionized and improved every aspect of human life by improving the products and processes so that living is more comfortable. But much more has to be achieved.

Many efforts have to go in the supply of food, water, and energy to 100% of the population in the world, besides protection from diseases, violence, disasters, and access to joy of learning, communication and entertainment.

In pursuing these century's challenges, engineers must frame their work with ultimate goals of universal accessibility in the mind. In brief engineers will have to integrate methods and solutions with goals of the society. He will be required to seek ways to put knowledge into practice to meet the above challenges.

So far humans have demonstrated a limited understanding of the dynamics on interactions between natural and human systems. The engineer of the future is expected to apply scientific analysis and holistic synthesis to develop sustainable solutions that integrates social, environmental, cultural and economic systems.

Engineering education needs to be changed to address the challenges associated with the global problems [1], analyzed in the light of systems Engineering Concepts.

The social problems are due to population explosion, aggressive behavioral trends, unemployment, degradation of environs, pollution & global warming, dissipation of mental energies, cheating trends, laid back attitudes, lack of commitment to life and ethics. The outcome is a drastic reduction in the interest to learn by the individual.

1.2 BROADENING THE THINKING

EDUCATION TODAY MUST BE INDUSTRY CONNECT. Every institute must be comparable with the best of the world and opportunities for learning must be created at different stages. The force within has to be kindled and power unleashed for every potential engineer.

It is a challenge to the education system to counter these trends of the society in order to see that the future students make a positive contribution to society. It is responsibility of the teachers to create a sincere, aspiring mindset in the students. Also the curriculum or syllabus framed must make the teachers and students responsible to the society. There are many issues to be considered for good curriculum development.

India has many engineering colleges and many graduates, with various engineering programs, but many are not equipped with skills and tools to lead life. We should be more concerned with the unemployment problem, aggressive trends in youngsters to make living in no time. We are equipping the students with lot of bookish /theoretical knowledge, but we are unable to provide sufficient practical knowledge and hands on experience in laboratories. We are neither dealing with true practical applications in the classroom nor allowing the student to do more experimentation. **The pitfalls are limited industry connect and classrooms.** We need to modify the curriculum, so that complete experimental equipment, the necessary software must be procured and industrially experienced faculties who can provide their experienced industrial experiences have to be hired.

In fact teachers must share real life experiences with the students to expand or broaden their thinking. An absolute commitment is demanded from the teachers.

Broadened thinking depends a lot on the genetic background, familial environs, and constructive knowledge tools received till K-12 and during the engineering programme. In the curriculum of the engineering programmes there should be 50% emphasis on experimentation in laboratory.

Wisdom and worldly wise knowledge would improve when operating intuitively and continuously, with an aspiration to contribute positively to the industry. Effective teaching techniques can be developed when teachers and students are course conscious, and aspire for continuous improvement. We must review and reflect to improve the education programme in enabling to meet educational goals.

Students need training to improve analyzing and problem solving capability in the light of, "Algorithmic Thinking ", "Computational Thinking" suggested by CMU [3].

Vocational training for primary industry is the heart and soul of strategic planning of the education system. In other words the most critical thing is enabling a skill oriented system. A high performance work force (skilled workforce from industry), through quality education requires demonstration and dissemination of knowledge and skills.

We need a reputable student success rate alignment of university with industry needs; tangible outcome in industry, industry leadership & successful core businesses. We also need systems & processes, support and partner ships between education system and industries.

In order to explore a learning pathway in industry we need Pre-work training. We need to get out of classroom to a heavily practical learning environ and begin experiencing success in learning.

We must emphasize on some principles related to teaching learning & student support. Lot of thinking has to go in preparing a whole person who is more self -managing type and enthusiastic to contribute positively. We must have a thorough plan, deliver and success, for program development, program delivery and professional development, planning programmes with review at various stages.

Quality learning benefits a diverse group of stakeholders' viz., quality teachers, and great tutors. Further quality guidance & support, Quality programmes and quality internal support are necessary. Other than incorporating the practice oriented subjects in the syllabus, we need certain strategies to resonate during the programme design and teaching so that constructive approaches to practice based learning would emerge. The strategies should be in respect of: (1) Inquiry based learning (consisting of ask, investigate, create, discuss & reflect),

(2) Project based learning, integrated teachers solving more case studies, simulated work place experiential scenarios etc. The laboratory experimental equipments must be designed if they do not exist.

1.3 CAUSALITY

We need to generate greater causality thinking in the young potential. The causal thinking can be taught, through generation of causal flow diagrams. A full discussion among the students must be encouraged, during the diagram development. The main principles behind the use are participation methods with the necessary tools required for practical use. In the beginning the approach must be demonstrated to students with discussions to express the views' and analysis.

The group must develop a causal flow diagram [4], for each activity with causes and the

impacts. Analyze the causal flow diagrams given by several groups of students. This analysis & training generally is made through case studies.

1.4. CREATIVE DESIGN

The subject „Creative design' generates ideas for identifying design opportunities and concept development. This needs greater cognitive capability, and the compulsory for every engineering program. This may also consist of the courses with main focus on creative engineering problem solving through project design, presentations etc.

1.5 STEPS IN CULTURING CREATIVITY

The contents of this design course can be:

1. Defining creativity, innovation, and design, to give overview of the role of creativity in engineering design process,
2. Outlining creative thinking strategies and thinking styles,
3. Explaining creative techniques to generate idea or solution,
4. Familiarization with design software as a tool for digital sketching,
5. Educate and cultivate the student to be a creative person,
6. Develop understanding of the design by defining and innovation and its relationship with creative design course.

In short the student should be able to learn and apply the design process in steps, apply the engineering principles learnt in the class as a team , search for alternatives for the selection of solution procedure, describe the scientific principles, develop and apply drawing & sketching skills, generate and report design project. In other words engineering colleges must become the laboratories where creativity is cultured.

2.1 NEURO-PSYCHO-PHYSIOLOGY (NPP)

Michael Trimarchi [5], proposed **Neuro-psycho-physiology (NPP), which** is a scientific discipline which integrates Neurology, Psychology and Physiology and focuses on the relationships between mind and nervous systems. It is a study of human behavior incorporating the principles of Neuroscience and Neuropsychology (including cognitive psychology). This examines the human behavior scientifically.

Several specific areas of the brain have been identified and are believed to be responsible for processing the subjects like language, mathematics etc. For example in the case of language processing like grammatical processing, syntactical processing, recognition of visual symbols, analytical processing etc left hemisphere plays a major role[7]. The right hemisphere specializes in the thought processes related to geometry, shape size of the objects, design skills, global holistic processing etc. These range from an analytical left brain to right brain involving pattern matching imaginative thinking, and intuitive understanding. The right hemisphere is also responsible for expression, reading of the emotions, interpersonal styles. All this is due to the main research activity of the Noble prize winner Sperry. There are also certain studies related to four quadrant model and or octant model of the brain.

The creative thinking and problem solving techniques can be implemented as personalized **Blended Education Program. Blended Learning** [6] a fusion of face-to-face learning and on-line experience. This approach is based on BLIS (brain lateralization of Information Systems. The Blended course integrates online component

and concomitant face-to-face seat time. But the online component must be limited to viewing the demos of experiments only.

2.2 IMPLICATIONS

In other words lot of work has been carried out on the theory of left –right dominance and learning styles [8]. Also work has to be carried out to identify the styles useful and the methodologies to be adapted to impart the necessary training programmes. In other words selection of the course is made suiting to the learning style, methods of delivery of the material, activities that strengthen the style and different modes of thinking. Initially tailor made courses have to be developed, so that young potentials become more fast learners.

It is necessary to keep in mind the convergence of the different models of learning which have some flavor of left-right specialization. Both sides of the brain are responsible in initiating and improving the skills like accumulation of information, critical analysis of the sources, organizing the information in a coherent fashion, filtering for the relevance, systematic presentation skills and time management. Thus It is necessary to prepare inclusive learning styles and the models of thinking to be used in imparting the concepts.

Some of the suggestions for curriculum Designers are

1. *There must be 50% emphasis on laboratory work in respect of grades*
2. *All theory classes must be taken in the laboratories only.*
3. *The contents of the syllabus of each theoretical paper must have demonstrable topics – so that the student assimilates the concepts easily.*
4. *The origin and development of concepts / Phenomena must be explained to students in a constructive fashion.*

It is worth examining the above studies as team work and design approaches through quiz programs and answering questionnaires so that engineering skills can be improved. These exercises have to be developed and syllabus must be modified so that the young potentials become true engineers. Finally **—What we have to learn to do, we learn by doing" – Aristotle**

CONCLUSION

To make the programs more effective – efforts must be made to modify the curriculum. We must keep in mind

1. How to stimulate the objective perception of reality.
2. There must be 50% emphasis on lab / experimentation.
3. We keep in mind the Neuro-psycho-physiology and Lateralization of the brain, which reduces the aggressive trends and creates focus in studies.
4. Also approaches to broaden the thinking in order to understand the concepts. Here the concept of general causality (cause and effect understanding of situations) analysis also will help.
5. Overall we would like to reduce the dissipation of concentration and develop a focused increased concentration among learners impervious to lures of environs.

Man should design and manufacture a machine, but Man should not become a machine, which executes routine jobs. Education must make him a true human being of higher order but should not lead him to destruction.

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