CHAPTER I
INTRODUCTION

"...There is hope, if education spreads throughout the country and people develop from their childhood qualities of pure conduct, God fearing and love."

-- Mahatma Gandhi

1.0 Introduction

Engineering, as a subject and practice as well, is very much a social activity with political, ethical and economic dimensions. It is a fact that there is worldwide transformation in engineering education driven by industry needs. Employment in Engineering warrants for a variety of skills, including visualization and communication skills. According to Lumsdaine and Lumsdaine, “Feedback from industry states that, Industry is increasingly looking for employees who can think holistically, who can innovate, who can work in teams, who can synthesize and who can integrate environmental and societal values and ethics in their work.”

Engineering Institutions in good number have been on the increase year after year all over the world including India.

The question is “Do the Engineering institutions produce Engineers with Employability skills, otherwise known as Non-technical skills?” According to Burse, the answer is “Studies worldwide have revealed that employers believe, entry level engineering employees are incompetent in the broader non-technical skills”. Narsee, confirms this view saying, “Employers also felt that educational institutions need to place more emphasis on teaching the so called softer skills”. His paper throws more light on the feedback of the other two stakeholders, namely, the Industry and the Governments.

In the light of employability skills, irrespective of field or subject, there is always a skills gap between the skills expected by the Industry
and what is actually available with the graduates. This is a phenomenon applicable to all areas at all times. The main attribute contributing to the above phenomenon is the ever dynamic and fast changing organizational climate and workforce requirement. The issue of skills gap seems to get complicated in the present day environment due to innumerable factors such as globalization, technological developments, faster obsolescence rate in Computer Science and Technology, multi-cultural working environments, International competition, demands of the present generation and the like. Engineering and Technology based industries are not exception to this situation. Though initiatives and measures are in the continuous updating process at the national and international levels, they are not able to zero the skills gap. The more attempts are tried to bridge the gap, the more the requirements go on increasing. Hence, the problem of skills gap warrants for a continuous surveillance and vigilance is required in this area to bridge the gap and meet the industry needs.

A mismatch between the industry needs and the competence of entry level engineers do exist. National Governments and International Engineering bodies have been evolving standards and analytical reports periodically in order to help the engineering institutions bridge the gap. The Government of India is aware of the crux of the problem and is on the move to introduce legislation in the context of bridging the skills gap. Regarding the steps for improving the situation and enhancing the standard and quality of Engineering education, in accordance with the industry needs and expectations, a lot of changes are on the way to revamp the way the Education System is governed in India. Changes have reached the doorsteps through the formation of working groups. In this context, a lot of situation audits are essential. This investigation may contribute its mite to the thoughts and initiatives inclined towards solutions to bridge the gap with a healthy national economy in mind.

The widespread discussion is on the concept of bridging the gap through making provisions for the development of the basic/generic skills
and re-engineering of education. All these belong to a top down approach. The problem needs a bottom up -- *ex ante* approach also. The development should be addressed when the students are young and the philosophical foundations of education should be made stronger with appropriate thoughts towards achieving a wholeness of development in the mind and the body of the student. All these depend on the philosophical foundation of education in its right perspective. Indian tradition of education is, no doubt, has a rich heritage with laudable philosophical base the pinnacle of which lies in Gandhian thoughts.

### 1.1 Philosophical Foundation of Education: Gandhian Perspectives

India is the land of Mahatma Gandhi. He is remembered all over the world for many of his contributions in general. Besides Indian independence, his contributions are found remarkable on Education, Non-violence and Human rights. His writings encompass almost all the facets of human life and they have been crowned with an eponym "Gandhian Philosophy". Gandhian Studies involving Gandhian thoughts are known as *Gandhiana*. Given Gandhi's values and his vision of what constituted a truly civilized and free India, it is beyond one's surprise, that he developed firm views on education. He expressed stronger views that, Education not only moulds the new generation, but reflects a society's fundamental assumptions about itself and the individuals who compose it.

Gandhi’s writings in general are found to be in the context of Indian independence concentrating more on the elevation of rural India with a stream of consciousness for discipline in individual and social life as well. His thoughts and expressions emphasized the need for making the rural mass self supporting thereby not only reducing the burden on the Government but also making every village self sufficient and every citizen confident with life skills taught with Basic Education during childhood.
Analysis of Gandhian Education from a right perspective reveals that education aims at the development of the individual's mind in its intellectual and spiritual dimensions. With an analytical view, Joseph C. Mukalel confirming the Gandhian view, expresses that Gandhian Education attaches great importance to the development of the individual's personality. Gandhi says, "The fundamental aim of basic education is to provide mental and moral development through any handicraft". Any educationist would like to consider the inclusion of handicrafts in 'basic education' for the child, as the inclusion aims to sow the seed for developing both technical and non-technical skills for a meaningful future life.

Gandhian philosophy of education is found reflected in a publication by Lave and Wenger who view learning from the perspective of the 'whole' person, not just the body of knowledge, rather the “interplay between both where the ... agent, activity, and the world mutually constitute each other”. They go on to explain that learning is only situated in practice, and conclude that learning is “... an integral part of generative social practice in the lived-in world”.

Gandhi’s name is not referred explicitly in Education Committee reports but, many of the principles and practices of teaching in Indian School Education system, reflect the preaching of Gandhi, though the manner and menu for the basic skills have changed a lot. Vision of Gandhi comes to the mind, while searching for some evidence on the non-technical skills required for an entry level engineer. According to Gandhi, “The state that you are an educated individual comes to an end the moment you are unable to bring your emotions under control and when your heart is not pure”. This principle comes under Education in its theoretical roots of Emotional Intelligence which is required very much for engineering professionals today. All these could be found in the writings of Mahatma Gandhi, when one looks at Gandhian Philosophy, without a touch on controversies on Gandhi's thoughts on Education. According to
a popular saying that 'literature holds the mirror upto nature', the viewer is able to see what he searches for in Gandhi’s contribution. Gandhi is a prophet in his foretelling that it is not knowledge alone but a social attitude that makes education complete. The immediate next generation following that of Gandhi, realized the true values of Education and formed a firm base upon which the edifice of modern education in India grows. Education, whoever defines, speaks in the context of individual development – both body and mind, ultimately contributing to the promotion of social welfare.

1.1.1 Education - Modern Perspective

Aldous Huxley blends individual development with social responsibility, when he comments, “a perfect education is one which trains up every human being to fit into the place he or she is to occupy in the social hierarchy, but without, in the process, destroying his or her individuality”. In Indian tradition as Dr. S. Radhakrishnan puts, “education is not merely a means to earning a living, nor is it only a nursery of thought or a school of citizenship; it is an initiation into the life of spirit, a training of the human soul in the pursuit of truth and practice of virtue; it is a second birth.” In his definition of Education, Radhakrishnan reflects Mahatma Gandhi in tone and spirit while including the term 'soul'. Education from the Indian context, should involve primarily self realization.

1.1.2 Education: Self Realization to Societal Fulfillment

Looking into the aims of education, apart from its primary goals as enabling individuals to grow personally, to achieve the self fulfillment and to develop the society through the individuals’ social commitment and responsibility, it must enable one to stand on his/her feet. Beyond the general education, technical education has a great role in the development of the individuals and societies at large. Technical education
is a necessity in every country in the modern age. Perceiving the needs of the time, Secondary Education Commission in 1953 stated that, ‘important aim of our educational system could be to increase the productive or technical and vocational efficiency of our students’.

Teichler posited that higher education should serve three functions when preparing students. “The educational function: to stimulate the cognitive, intellectual and systematic abilities and to convey knowledge which is conceived as broad, general, or the core of cultural and civilization competences; The training function: to foster knowledge and competences targetedly provided in order to prepare students for future professional practice in related areas of specialization; The socialization function: to shape the values, attitudes, social behavior and the communication skills relevant for action in socio-communicative contexts.” There has been a significant shift in the history of education transforming the traditional teacher-centered approaches to learner-centered ones.

1.1.3 Engineering Education

Luiz et al., state that, “Engineering and technology are critical inputs for economic development and competitiveness.” Engineering Education directly or indirectly contributes to the Gross Domestic Product of every nation ultimately leading to human welfare. The present day society is acclaimed to be an information society, knowledge society or network society. Apart from how it may be called, its most visible element is the rapid development of the Information Communication Technologies, and the fast increasing amount of information. The society is passing through a transformation. According to Tynjala et al., “New kinds of expertise are needed, and many organizations have turned into knowledge intensive innovation centers in which collaborative work, networking, and transformative and creative learning have become key
concepts in organizational development. This change affects also engineering education.”

Engineering Education has been rightly defined by the Knowledge Commission of India in its recent report as, “Engineering education consists of three well-defined aspects -- knowledge, know-how, and character. The knowledge component enables one to understand what one learns in relation to what one already knows and provides the continuity in education while know-how is the ability to translate knowledge into action. The knowledge component has an invariant core that consists of fundamentals based on universal laws and an outer layer of constantly improving and rapidly expanding empirical knowledge of particular systems, constantly changing applications of increasing sophistication and complexity and constantly improving tools. Education thus described is a combined responsibility of academia, industries, professional associations and society.”

A nation’s educational program should, among other things, aim at solving the problems facing the nation and improving the economy through wealth creation. It is well known that engineers contribute to such a wealth creation and shape the future of the nation. Many nations, whether developed or underdeveloped are looking inward, studying the trends of change, suggesting and making modifications to their engineering education content in order to produce engineering graduates capable of carrying their nations through the change and challenges of time.

Szpytko states that, “The expansion in technology and materials development has been so rapid that for the first time in our history we have made obsolete many of the rules and much of the infrastructure that serves society’s needs today. The effect of globalization has driven through tremendous changes within the industry world-wide.” He further adds that, with technology advances, workplace changes can lead to exciting and rewarding careers that may require to be flexible and committed to continuing professional development. The key to survival is
establishing a framework for life-long learning world-wide. In the face of business globalization the engineers must sharpen their capability to communicate both in the written and oral modes and must work in teams to tackle issues and resolve problems.

According to Grabowski and Szpytko\textsuperscript{12}, “Engineering education for the 21st century must prepare students, the future technologists to face real world problems, to satisfy industry needs. Graduate students must be prepared for a rapidly changing environment, driven by the accelerated rate of technical innovation, essential skills for the future, the ability to engage in life-long learning, to communicate and cooperate across disciplines and geographical boundaries.” This phase of the engineering education and industrial needs, seen through the eyes of an engineering student should be on his/her search for a future employee. Engineering education in India has its firm foundation since long.

1.1.4 Engineering Education in India

A recent publication entitled ‘Profile of Engineering Education in India’ by Gautam Biswas et al.,\textsuperscript{13} provides a comprehensive picture of Engineering Education in India. The initial years immediately after Indian independence began to witness a planned development in Engineering Education. The establishment of Indian Institute of Technology by the Government at the centre marked one of the greatest hallmarks of visionary development in the Independent India. On the recommendations of the Engineering Personnel Committee appointed by the Planning Commission (1955), the Government of India made provisions for the establishment of eight Regional Engineering Colleges (REC) while seven more were added by bringing the total number to fifteen besides strengthening the PG courses and doctoral programs in Engineering. The Thacker Committee (1959-1961), the Nayudamma Committee (1978-79) and The Rama Rao Committee with their recommendations helped the Government add on appropriate values and measures to the refinement
of Engineering Education. It was the Rama Rao Committee that supported 'GATE' system of admission and revision of Engineering Curriculum on a practical training orientation. The formation of the All India Council for Technical Education (AICTE) as a regulating body for the conduct of courses in Engineering and Technology, has been working for enhancing the quality of Engineering Education as the accrediting body also.

The number of Engineering Colleges and Deemed Universities in the private sector in India proliferated at a faster rate felicitated by provisions in the National Policy on Education. According to the report of the Knowledge Commission, Engineering institutions in India currently [2009] account for intake of more than 5, 00,000 students in Bachelor’s program, around 30,000 in Master’s program and less than 1000 in PhD program. The number of institutions has also grown by an order of magnitude in the last two decades, mostly in the private sector. This rapid expansion has raised serious concerns about the quality of engineering education in these institutions.

Engineering Education is administered by the Ministry of Human Resource Development (MHRD) through the All India Council for Technical Education (AICTE). AICTE provides the guidelines for starting new programs in Technical Education and is also charged with accrediting the programs through the National Board of Accreditation (NBA).

It is not the degree alone, but the generic or non technical skills too that are counted for employability. Frantz et al., 14 confirm that the quality of technology education programs is greatly determined by the successful students having acquired the skills, knowledge and values needed by society, more specifically the workforce. Engineering Education should be able to help a nation achieve higher economic growth rate through effective employment of engineering graduates.
Industry gives priority to employability skills rather than academic merit alone. The final result is that students may not get placed on the one hand and on the other, industry is not getting proper candidates. Also those who join the industry may not possess the expected competency.

1.2 Employability Skills Gap

It is an acknowledged fact that knowledge, skills, and resourcefulness of people are vital to sustain social and economic development in a knowledge society. Employability is defined as the acquisition of those skills, which not only help in landing in a job but also allow a person to sustain. Currently while there is no dearth of opportunities in the employment scenario, there is a serious lack of employable talent. While there is abundant talent in India, the proportion of industry-ready candidates is alarmingly low, posing a huge challenge for the industry in meeting its requirement, questioning the future of engineering graduates coming out of the college and university portals. Attributes to this problem are many.

1.2.1 Employability Skills Gap: Attributes

The skills gap on the industrial environment between industry’s expectations and the Engineering Graduates’ competency, is getting widened due to many reasons -- both from the part of the industry and from the part of the candidate.
1.2.2 Nature of the Industry

Different from older times, industry is moving through critical stages which warrant maximum amount of changes in products, processes, approaches, appearance and many other factors. Earlier an industry would be producing only a few variety of items with minimum number of options in the same variety, whereas today variety and novelty with wider implications and applications have become the buzz word. What difference a product, or process or service makes from others is the question the public is putting across. Thus, industry is under heavy pressure to go for change. If this is true in manufacturing industry, it is more valid in the modern IT, Electronics and other areas of industry. Every day a new challenge is appearing. Everyone looks for a tailor made solution. Dynamism is very much injected into the system. Hence the traits and training imparted in the academy for usual solution would be totally insufficient to meet the latest needs.

1.2.3 Delay in Translation of the Need into Academy

The translation of the need of the industry into academy is more mediocre as the industry-institute interaction is not vibrant. Every facet of innovativeness of the industry, ideally speaking, should create reverberations in the academy, which is not the real case. Academy should respond as the conscience keeper of the industry, which is a real task. Many a time, industry and academy keep themselves off from each other as if they have no role to play in solving the problem.

1.2.4 Curriculum Development: Difficulties at University Level

Even if the demands from the industry are brought to the notice of academy, universities find it really hard to implement the changes required. To initiate a change at a university level, the system has to
overcome a lot of bureaucratic and official delays, which basically emanate from human lethargy. Such situations emerge very frequently with least concern for academics. Though periodical syllabus revision is mandatory, road blocks against any such revamping processes are very much rampant in University systems.

Revision of Syllabus becomes a task due to many considerations as political, regional and others which come into play delaying the entire process. In the affiliated system, the problem is very acute. Too many cooks are there to spoil the broth. Books and materials may not be available. All these add to the severity of the issue. Even if institutions make serious attempts to incorporate the industrial needs and latest developments into the syllabus, in an affiliated system, they are extremely helpless to implement the same. Even if they teach something other than the exam bound syllabus, students very often may not show keen attention as this is not remunerative in terms of marks and consequent rewards. This is mostly because of the low motivation of the students, which may be the case in many states of the Indian Union.

1.2.5 Indigenization, Value Addition

In spite of the encroachment of globalization, something truly Indian must be encouraged at the traits development level too. Appropriate technology is not targeted in many cases. Equally concerning issue is ethical and moral aspect of the industrial products, personnel and environments. Rave parties are organized by corporates to capitalize the capabilities of employees and to exploit them to the maximum. The family life, moral aspects in the personal life of the individuals in industries, all must be concern of the society. Technology with a human face is something to be achieved. This scenario also plays a role in bridging the gap.
1.2.6 Innovation and Creativity

In the mismatch issue, the quest for innovation and creativity have important roles to play. The first concern in academy and industry as well, must be to trace and identify the traits of creativity in individuals and then to support and motivate the same at various levels of activities. This should start with the academy and continue into the industry. In most cases academic performance and creativity may not be in direct correlation, which makes the scenario very intricate.

1.2.7 Aptitude and Motivation of the Students

In the new millennium, the state Governments have opened up the engineering and medical education to the self financing sector. In the place of six engineering colleges in Kerala, the number exponentially has gone up to around 120 in 2010. The input of students does not seem to have changed very much in quality, but in quantity. It was 2000 candidates per annum earlier and now 40000 students are in the fray and a natural dilution in intensity of motivation and hard work has taken place. Many students join the college for engineering without motivation and proper attitudes. Social pressures as status symbol, parents’ excessive interest in the welfare of their wards, play crucial roles and consequently many end up with disasters with subsequent rejection by the industry finally. Even the choice of branch for study in most cases is very arbitrary and is depending much on popular opinion rather than the actual aptitude and flair of the candidate. Popular opinion is very much unscientific and appropriate guidance and counseling are missing.

Maslow proposed a hierarchy of five needs namely physiological needs, Safety and security needs, social needs, self esteem needs and self actualization needs. The children, before finishing their schooling and leaving the school premises should be given to achieve self actualization,
as found promulgated in Maslow\textsuperscript{15}. Culmination of Self actualisation in every student shall pave the way to motivation. According to Maslow, self actualization is the apex reached by an individual after all the previous four needs are satisfied.

In academic psychology, Maslow\textsuperscript{16} has been criticized for his lack of scientificity. In recent years, Maslow's ideas have been taken up by the "transpersonal" psychologists. In a review of Maslow's theory, Heylighen\textsuperscript{17}, states that “personality is based on: 1) a theory of human motivation, characterized by a hierarchy of needs; 2) a description of a particular type of maximally healthy personality, called "self-actualizing", which is supposed to emerge, when all these needs are satisfied.”

Promoting self actualization can help achieve the objectives of any program to put the entry level engineers at the right track with their personal skills in a full bloomed style. Northup expressed that, “One of the best known models describing human motivation and personal development is the Hierarchy of Needs developed by Dr. Abraham Maslow. Below is Maslow's model with a brief description and application of how it applies to the workplace as visualized by Northup\textsuperscript{18}.

**Need - Workplace programs**
Thomas Northup, correlating Maslow’s five needs with workplace in his article entitled “Traits Successful People Possess: A Leader’s Path to Excellence” sums up that, “The difference between being average and successful is small. A successful person doesn’t work harder, he or she works with a distinct goal in mind. For this reason effective leaders strive to strengthen success traits in themselves and their employees. And this effort has personal benefit for the leader. The adage of leadership; the more success your employees have the more success you will have. Personal and organizational successes go together. When employees meet their personal goals as they help the organization meet its goals, they make great achievements possible. Effective leaders build an environment where personal and organizational goals complement each other. They build a positive work environment where people stretch toward excellence. They share power with their management team to bring the full effect of personal motivation to organizational initiatives. Effective leaders build an organization of committed people who together accomplish great feats. They believe in the adage: Self motivation is the power that raises you to any level you seek.” Northup in his article uses the first person narration. A much criticized theory of Maslow is found beautifully correlated to the workplace in a globalised environment in Northup’s paper.

### 1.2.8 Globalization -- Changing Needs of the Employers

In the new millennium, globalization has been emerging as a powerful force in shaping domestic and world economies. It is removing the trade barriers between nations and promotes the integration of nations’ economies through financial flow, trade in goods and services, and corporate investments between nations. Globalization is on the increasing trend due to the fast progress in Communication, Engineering, Science and Technology. “India also joined the current as early as 1991 by bringing changes in its economic policy for allowing direct foreign investments in the country.”
For the past two decades, there have been changes in the specific skills required to enter and succeed in the work environment. Employers have talked about the importance of new skills for employees to work more effectively. Among the skills that employers look for are: communication skills and ability to use general skills in the workplace. These include the ability to write, speak and calculate, the ability to work in groups and the ability to listen effectively. Employers are also looking for employees who are adaptable and flexible, have good work ethics, initiative and possess leadership skills. Any report on the global trend, from the employers’ point of view does speak of the gap between Engineering Graduates' competence and the Industry needs.

Organizations and their clients have limited tolerance for inept performance of entry level engineers. Often engineers have to engage directly with clients in complex interactions. Educators are expected to teach competencies that are relevant and enhance an organization’s performance as Wilkinson\textsuperscript{21} observes in his publication. Universities around the world have become increasingly aware of the need to be able to demonstrate, in a quantifiable manner, the skills and attributes that their graduates are imbued with during their learning experience as expressed in a paper by Waters et al.,\textsuperscript{22}. Reforms in Engineering Education have a long but slow history. Felder\textsuperscript{23}, remarked, “We teach primarily mechanics, and not reasoning methods; memorization and routine application, and not analysis, synthesis and evaluation. We don’t encourage creativity and independence of thought, and in fact often do our best to discourage them.” Sadly nothing much has changed on the ground. The community that is responsible for transforming the life style of the world has not yet transformed its own educational process as observed by experts.

1.3 Competency

There are numerous definitions for ‘competency’ available in the literature. The New Zealand Qualifications Authority (NZQA, 1997),
defines that, “competency is the ability of individuals to apply knowledge, skills, attitudes and values to standards of perfection required in specific contexts.” Spencer and Spencer\textsuperscript{24} define competency from an industry perspective seeing competency as an "underlying personal characteristic of an individual that facilitates superior performance in a given situation." According to Boam and Sparrow\textsuperscript{25} competency is an input measure where competency is seen as any aspect of the inner person, normally displayed as behaviors, which allow them to perform competently. In other words, competency is an output or outcome measure.

At present, the need for producing employable graduates is being increasingly felt across higher education institutions. Keeping in mind the requirements of the industries, several institutions have started imparting training to their students in developing employable skills.

\textbf{1.3.1 Intelligence and Skills}

Earlier research focused on cognitive aspects of intelligence such as memory and problem solving. Later, non-cognitive aspects also came under study and research. David Wechsler\textsuperscript{26} defined intelligence as “the aggregate or global capacity of the individual to act purposefully, to think rationally, and to deal effectively with his environment”. Moreover, Wechsler was of the notion that “one cannot expect to measure total intelligence until our tests also include some measures of the non-intellective factors", and also Wechsler in another publication\textsuperscript{27} discussed his initiatives to measure and appraise adult intelligence with reference to "non-intellective" as well as "intellective" elements, by which he meant affective, personal, and social factors. Such research and discussions led to the birth of the concept Emotional Intelligence.
1.3.2 Emotional Intelligence

The term Emotional Intelligence was coined in 1990 by Salovey and Mayer\textsuperscript{28} who reviewed the previous works on intelligence and described Emotional Intelligence as “a form of social intelligence that involves the ability to monitor one’s own and others’ feelings and emotions, to discriminate among them, and to use this information to guide one’s thinking and action”. Based on their reviews of the previous works on intelligence, they initiated a research program intended to develop valid measures of Emotional Intelligence. The whole idea of emotional intelligence as something worth serious study appealed to an emerging group of researchers who were becoming concerned with how poorly traditional IQ tests predicted an individual’s future success.

During the early 1980’s the concept of "multiple intelligence" (MI) was firmly established among psychologists and it came to be recognized that non-intellective intelligence was as important as the type of intelligence typically measured by IQ tests.

Whenever the term intelligence is used, occurrence of similar terms such as reasoning, skill and/or ability are also found used along with. For example, the concept ‘verbal intelligence’ is used as verbal reasoning or verbal skill or verbal ability. The clarification is found in a publication by Godfrettson\textsuperscript{29} who expressed that, "Although there is a debate about the precise definition of intelligence, there is agreement that it reflects the ability to reason, solve problems, think abstractly and acquire knowledge. Intelligence affects the ability of people to recognize, acquire, organize, update and apply knowledge effectively. It is related to the ability of people to deal with complexity." Terms referred here are used as equivalent to explain the basic concept ‘intelligence’. They are used to denote the process concerned with intelligence and its transfer process and levels from formation to application.
According to Graduate Skills Assessment Committee report (GSA), the term "skill is used to describe the crystallized ability of students to deal effectively with certain kinds of higher order generic reasoning. The term 'generic skills' refers to general, transferable skills of a kind that can be widely applied in academic work and graduate employment".  

Birkett\textsuperscript{31} developed a taxonomy of cognitive skills and behavioral skills. According to Birkett, cognitive skills include technical skills - the application of technical knowledge with some expertise; analytical/constructive skills - problem identification and the development of solutions; and appreciative skills - evaluating complicated situations and making creative and complex judgments. Behavioral skills include: personal skills - how one responds and handles various situations; interpersonal skills - securing outcomes through interpersonal relationships; and organizational skills - securing outcomes through organizational networks.  

Literature in and across the western world suggests that when it comes to identifying key skills that employers seek in graduates, ideas about generic 'work readiness' and 'soft' skills are seen to be as important as technical and cognitive skills. There have been different terminologies functioning as synonyms and near synonyms. Hard skills, technical skills and cognitive skills denote the skills academically acquired. The terminology 'generic skills' also belong to this category. ‘Hard’ skills include technical, analytical and appreciative skills. Technical skills relate to the specific ability to apply learned expertise to a task – such skills are often very specific to the course and subject matter taught at university. Analytical skills relate to problem identification and problem solving, while appreciative skills relate to the ability to evaluate and make appropriate judgments about complex situations, as expressed by Coll and Zegwaard\textsuperscript{32}. They further reiterate that ‘Soft’ skills are a combination of personal, interpersonal and organizational skills. While these types of
skills are not necessarily the ‘learned’ skills that universities are able to base curricula around, they are highly sought after by employers.

According to Page, Wilson, and Kolb\(^3^3\), “Hard skills are skills associated with technical aspects of performing a job and usually include the acquisition of knowledge.” Hard skills thus are primarily cognitive in nature, and are influenced by an individual’s *Intelligence Quotient* (IQ).

Soft skills are skills often referred to as interpersonal, human, people, or behavioral skills, and place emphasis on personal behaviour and managing relationships between people. Soft skills are primarily affective or behavioral in nature, and have recently been associated with *Emotional Quotient* (EQ) popularized by Daniel Goleman as expressed in individual, separate publications by Caudron\(^3^4\); Kemper\(^3^5\); McMurchie\(^3^6\).

Hard and soft skills are now regarded by many authors as being complementary. “The successful individual performance in the workplace requires both types of skills, and superior performers are found to have high Emotion Quotient (EQ) as well as high IQ ratings” as opined by Kemper\(^3^7\); McMurchie\(^3^8\). For example, research by Spencer and Spencer suggests that superior performers are not distinguished solely by the technical skills, but by the demonstration of certain motives, values, traits and attitudes, in other words, by manifestation of good behavioral skills in addition to their technical ability. As such, non-cognitive skills play a vital role and come to be counted into the ‘employability skills framework’.

1.4 Employability Skills Framework

The nature and scale of the ongoing trend in Engineering and Technology implies for the quality of human capital in the 21st century posing critical global and national challenges as well. The situation shows the importance of acquiring *employability skills* amongst the job aspiring engineering graduates aiming at the industrial sector. "Employability skills are also known by several other names, including key skills, core skills,
life skills, essential skills, key competencies, necessary skills, and transferable skills. However industry's preferred term is employability skills."\(^{39}\)

According to the Department of Education, Science and Technology (DEST), "Employability skills are defined as skills required not only to gain employment, but also to progress within an enterprise so as to achieve one's potential and contribute successfully to enterprise strategic directions."\(^{40}\) Employability skills are referred to as generic skills by the British National Skills Talk Force, which defines generic skills as "those transferable skills essential for employability which are relevant at different levels for most (people related to workplace)."\(^{41}\)

DEST in its report entitled, 'Employability skills for the future' presents the findings of extensive research undertaken by the Business Council of Australia (BCA) and the Australian Chamber of Commerce and Industry (ACCI) in 2001\(^{42}\). The same report identified personal attributes required for employees, as well as eight employability skills which were seen to have relevance to both entry level and established employees. The eight identified skills are

1) Communication skills that contribute to productive and harmonious relations between employees and customers

2) Teamwork skills that contribute to productive working relationships and outcomes

3) Problem solving skills that contribute to productive outcomes

4) Self-management skills that contribute to employee satisfaction and growth

5) Planning and organizing skills that contribute to long-term and short-term strategic planning

6) Technology skills that contribute to effective execution of tasks
7) Life-long learning skills that contribute to ongoing improvement and expansion in employee and company operations and outcomes
8) Initiative and enterprise skills that contribute to innovative outcomes.

Employability skills are therefore a significant subset of a broader set of generic skills which have come under the sharpened focus of studies in the light of globalization and related factors.

But yet, “Only 25 per cent of students are employable and the rest are not, from the industry point of view. The component of employable skills is severely lacking in many students. They might have technical skills but these sub-skills are not up to the threshold. So, companies do not come forward to absorb such students,” says V. Prithiviraj, Principal of Pondicherry Engineering College. Proficiency in soft skills is definitely a pre-requisite for graduates and it improves their chance of being selected for employment, he notes. Pondicherry Engineering College (PEC) has included general proficiency in the curriculum ranging from the third to sixth semester, dealing with all aspects of communication skills with emphasis on practical skills.

To the question, What do industries look for in engineering students?”, many academics and HR departments opine that aptitude, problem solving skills, logical ability, experience in facing challenges, communication and self-presentation skills are felt to be the key requisites. In fact, fear to communicate during group discussions is a huge hurdle for many. The university has entered into a pact with a number of companies to train the students.

“In McKinsey’s survey, Indian executives listed low availability of talent as the single largest constraint for future growth of their software companies in India. Respondents claimed that 80.7% of US engineers would be employable, compared with only 10% of Chinese engineers and 25% of Indian engineers. Major concerns about employing Indian
engineers focused on language proficiency, quality of technical education, cultural issues and a lack of accessibility." If extrapolated, this suggests that poor written communication skills will hamper attempts to adopt written communication skills in another language. This indicates that the importance of instilling sound communication skills in students, particularly in the engineering field, as this discipline has a poor reputation with regard to communication skills, as per the general opinion. As a remedial measure, “E-learning can be described as the automation of the processes of learning and training through the use of information technology” . This environment is suitable for the mediation of content. When it comes to the training of interpersonal skill, the capabilities of such an automated system seem to be limited.

While speaking about The National Association of Software and Services Companies’ (NASSCOM) role in preparing this model Detailed Project Report (DPR), Mr. Som Mittal, (President of NASSCOM) said, “Addressing the current skill gap is vital for the Indian IT industry to maintain its growth trajectory and move up the value curve. Skill gap here refers not only to the low employability of the current graduate pool but also to the future needs of the industry in frontier technologies and functional domains. While the former will be addressed through upgrading the curriculum, facilities and faculty development in the academic institutions, the latter will require the academic institutions and industry to collaborate in pre-competitive research and develop specializations. Given the increasing requirements of the IT industry, it is also important for the new institutes to scale up beyond the conventionally accepted numbers at both under-graduate and post-graduate and doctoral research levels”.

NASSCOM has taken a pyramid approach to better understand the IT-BPO industry’s skills requirement and thereby create specific skill development initiatives. Over the last few years, NASSCOM created a major workforce development platform and launched several initiatives, in
partnership with the Government and academia that aim to bring positive changes to the Indian education system and its orientation towards building employable students by offering solutions in the short, medium and long-term time frame. The main message of experts from educational institutions, employer federations and engineering associations is that industry needs engineers who on one hand have a breadth of basic knowledge and on the other hand can participate also in solving problems. *This requires* competence in the different areas included in the Differential Aptitude Test (DAT) battery and they are as follows:

1) Verbal Reasoning
2) Numerical Reasoning
3) Speed and Accuracy
4) Space Relations
5) Language Usage
6) Interpersonal and Intrapersonal Relations

In accordance with the industry needs of skills, the present study includes Emotional Intelligence and Fiedler’s Least Preferred Coworker after dropping Language usage, Abstract Reasoning, Interpersonal and Intrapersonal Relations and Mechanical Reasoning from the set of DAT battery.

### 1.4.1 Verbal Reasoning

Verbal reasoning refers to Verbal/Linguistic intelligence. According to Lazear, "Verbal reasoning is related to words and language. Knowing occurs through the written, spoken and read aspects of language." Edwords, in an interpretative way states that, "Its [Verbal Reasoning] capacities involve understanding order and meaning of words convincing someone of a course of action, explaining, teaching, and learning, humor, memory and recall, and meta-linguistic analysis." Individuals possessing this skill are those who often excel others with their communication skills.
Verbal reasoning ability is important for any work involving the communication of ideas or the interpretation of written material. It is vital for many kinds of work, in which analytical thinking is required. It is also important to have fairly good verbal skills if one may wish to undertake further training or study.

1.4.2 Numerical Reasoning: Logical-Mathematical Intelligence

Logical-Mathematical Intelligence is referred to as Numerical ability or Numerical reasoning. It consists of the ability to detect patterns, reason deductively and think logically. This intelligence is most often associated with scientific and mathematical thinking.

Edwords states that, "Among the many capacities for this intelligence are performing complex calculations, recognizing problems needing a logical solution, understanding numerical relationship and concepts, and remembering a series of abstractions". According to Bellanca\textsuperscript{49}, "Logical Intelligence includes the ability to use inductive and deductive reasoning, solve abstract problems, and understand the complex relationships of interrelated concepts, ideas, and things. Reasoning skills apply to a broad array of areas and include using logical thinking in science, social studies, literature, and other areas".

1.4.3 Speed and Accuracy

Speed and accuracy denote a person's ability to work accurately with detail and at speed. Such an ability is important in many kinds of routine or detailed work (clerical work, data entry or coding, for instance) and is also quite important for scientific or technical work where precision is required (e.g. computer programming or laboratory work). Furthermore, this is an ability required in all work where attention to detail and quality are important (e.g. accountancy and some types of legal work).
1.4.4 Space Relations

Space Relations is denoted by the term spatial relations or spatial ability also. Space Relations is defined by Eliot and Hauptman as the ability to organize the representation of information; and to generate, retain, and manipulate visual images. According to McGee Spatial ability is "The ability to mentally manipulate, rotate, twist or invert pictorially presented visual stimuli. The basic dimension of this ability appears to involve a process of recognition, retention, and recall of a configuration in which movement or transformation occurs among the discrete parts of the configuration; or of an object manipulated in three-dimensional space; or the folding and unfolding patterns."

The Space Relations test assesses a person's ability to visualize objects in three dimensions. This ability is needed for any form of work in which it is important to be able to visualize objects and to understand how they relate to each other. According to Sorby, "Spatial skills are critical to: (a) developing creative design solutions to problems central to engineering; (b) performing database manipulations in computers; (c) understanding aspects of structural chemistry, and (d) visualizing how a new building will interact with its surroundings."

Spatial visualization is at or near the top of the spatial-factor hierarchy, and appears to be part of the abstract reasoning required in solving mathematical problems, and is associated with tasks involving mental rotation.

1.4.5 Language Usage

The ability to use language is important in any job in which communication, either written or verbal, is involved. Examples of areas in which good language skills may be required are management, teaching,
professional work, work in the media (radio and television, journalism) and clerical/administrative work. The last test in the DAT series, Language Usage, assesses this ability in effective communication.

It has also been commented that it is with the aid of foreign language study ... that students have access to a different culture and new knowledge. Furthermore, language learning should not only be considered as a skill, but also as a creative medium to inform students' understanding of society. Engineering employers look for creative people with the technical expertise to take a good idea from conception through to completion, so it pays to keep IT skills up to speed.

Employers are likely to be more impressed by graduates who have put in a bit of extra effort in order to acquire these skills, rather than those who have simply met the basic requirements of their degree course.

1.4.6 Interpersonal Intelligence

This is the ability to quickly grasp and evaluate the moods, intentions, motivations, and feelings of other people. This can include sensitivity to facial expressions, voice and gestures; the capacity for discriminating among many different kinds of interpersonal cues; and the ability to respond effectively to those cues in some pragmatic way. According to Lazear, "Interpersonal Intelligence deals with person-to-person relationships and includes the ability to communicate with others and to have empathy for their feelings and beliefs. Knowing occurs through communication, teamwork, and collaboration."

Certain characteristics that identify this intelligence are working cooperatively in a group, sensitivity to other's mood, temperaments, and feelings, and creating and maintaining synergy (a feeling of fellowship and togetherness). Individuals exhibiting this intelligence often become counselors, psychologists, or teachers. Bellanca, stated that
Interpersonal intelligence “involves verbal and nonverbal communication skills, collaborative skills, conflict management, consensus building skills, and the ability to trust, respect, lead, and motivate others to the achievement of a mutually beneficial goal.”

A more complex interpersonal skill is an adult’s ability to read and interpret the hidden intentions of others.

1.4.7 Intrapersonal Intelligence

According to Armstrong, "Intrapersonal intelligence includes having an accurate picture of oneself (one’s strengths and limitations); awareness of inner moods, intentions, motivations, temperament, and desires; and the capacity for self-discipline, self-understanding, and self-esteem.”

The final recognized intelligence is Intrapersonal Intelligence. This intelligence has to do with the knowledge of "self". Among the identifying characteristics of this intelligence are meta-cognition (thinking about thinking), self-reflection and awareness of metaphysical concepts, awareness and expression of different feelings, and a higher order of thinking and reasoning. People exhibiting this intelligence are comfortable, and often content, to spend time alone. They are well aware of their own feelings and emotions and thus according to Gardner, Kornhaber and Wake, "this intelligence may act as a 'central intelligence agency,' enabling individuals to know their own abilities and perceive how to best use them.”

Apart from the skills, the Industry expects the entry level engineers possess workplace competencies.
1.5 Workplace Competencies

The enviable salary and higher monetary benefits to a fresh engineering graduate than his/her counterparts from other arts and science subjects, warrant for certain additional skills. In general, to sum up the categories of the industry needs and their vision is to recruit well-rounded people, and they increasingly look for evidence of:

1) leadership
2) communication
3) teamwork

1.5.1 Leadership

Leadership qualities are even more required as teamwork has become an inevitable part of the new phase of industry. Earlier, an individual could do much, provided the machines in working conditions were available.

1.5.1.1 Leadership: Fiedler’s Contingency Theory

Fred Fiedler believes that leadership effectiveness depends on both the leader's personality and the situation. Certain leaders are effective in one situation but not in others. Devices Fiedler uses to determine leader personality and the situation are Leadership style and Least Preferred Coworker and Leader-Situation Match and Mismatch.

The contingency theory of Fiedler postulates that there is no single best way for managers to lead. Situations will create different leadership style requirements. Fiedler noted three situations to define the condition of a managerial task and they are as follows:

1) Leader Member Relations: How well do the managers and the employees get along?
2) Task Structure: Is the job highly structured, fairly unstructured, or somewhere in between?

3) Position Power: How much authority does the manager possess?

Fiedler identified two types of orientation among managers in the context of leadership style and they are ‘Task focus and Relationship focus’.

1.5.1.2 Task Focus and Relationship Focus

According to the Fiedler’s theory, “managers can be rated as to whether they are relationship oriented or task oriented. Task oriented managers tend to do better in situations that have good leader-member relationships, structured tasks, and either weak or strong position power. They do well when the task is unstructured but position power is strong. Also they do well at the other end of the spectrum when the leader member relations are moderate to poor and the task is unstructured. Relationship oriented managers do better in all other situations. Thus, a given situation might call for a manager with a different style or a manager who can take on a different style for a different situation.”

1.5.1.3 Leadership Style: Least Preferred Coworker

The LPC scale is used by Fiedler to identify a person’s dominant leadership style. Fiedler believes that this style is a relatively fixed part of one’s personality, and is therefore difficult to change. This leads Fiedler to his contingency views, which suggest that the key to leadership success is finding (or creating) good “matches” between style and situation.
1.5.1.4 Least Preferred Coworker (LPC) Scale

The LPC is used to measure a leader's motivation: "Task motivation" vs. "relationship motivation". Fiedler assumes that everybody's least preferred coworker is, on an average, about equally unpleasant. But people who are relationship-motivated tend to describe their least preferred coworkers in a more positive manner, e.g., more pleasant and more efficient. Therefore, they receive higher LPC scores. People who are task motivated, on the other hand, tend to rate their least preferred coworkers in a more negative manner. Therefore, they receive lower LPC scores. So, the Least Preferred Coworker (LPC) scale is actually not about the least preferred worker. Instead, it is about the person who takes the test; it is about that person's motivation type.

1.5.1.5 Leader-Situation Match and Mismatch

A match exists between a task-motivated leader and an either very favorable or very unfavorable situation. A relationship-motivated leader, on the other hand, matches an intermediate favorable situation. Leaders can lead most effectively when there is a match between his/her motivation type and the situation. When the leader and the situation do not match, some things have to be changed. Since personality traits are relatively permanent, a better solution is for the leader to move to a better match situation. This is called "job engineering". Researchers often find that Fiedler's contingency theory falls short on flexibility. They also noticed that LPC scores can fail to reflect the personality traits it is supposed to reflect.

However, Fiedler's contingency theory is an important theory because it established a brand new perspective for the study of leadership. Many approaches after Fiedler's theory have adopted the contingency perspective.
1.5.2 Effective Communication

The second factor among workplace competence is Communication. Communication skill is the principal expectation and extremely important need of today’s employers. A recent survey, carried out by Capita Learning and Development, revealed that 47% of businesses rate communication skills as the most important area in which to train their staff.

“Evidence indicates that communication skills are what helped *Homo sapiens* evolve beyond our related ancestors, and that these skills have helped humankind develop into the advanced societies on Earth today.”\(^{59}\) However, these skills have become stifled in the very discipline that has brought so many advancements, namely Engineering.

There is ample evidence that graduate engineers lack the required standard of communication skills, particularly when compared to the needs of industry internationally\(^{60,61}\) and compared to related disciplines offered at universities (e.g. business). This is so much so that the Dean of Engineering at Duke University stated that … *engineers who are adept at communications have a considerable advantage over those who are not.*\(^{62}\) Furthermore, this lack of communication skills only serves to undermine the whole profile and image of the professional engineer. Comprehensive research needs to be carried out in order to determine the profile and focus on those communication skills required for general and, more specifically, for professional use, and how these may vary across cultures and are influenced by differing cultures.

Communication skills have to be considered as a vital aspect in the education of engineers. This has been reinforced by such skills being one of 11 key outcomes required in an undergraduate engineering program in the Global Congress discussions on Engineering Education in 2000\(^ {63}\). Communication skills are a regular feature of an engineer’s job in
industry; some graduates employed in industry have identified that education in communication skills needs to be improved, given the demands that have been encountered in industry\textsuperscript{64}. Indeed, communication skills are considered to be a valuable career enhancer\textsuperscript{65}. Carlson asserted that \textit{communication is not ancillary to engineering but rather at the heart of engineering}\textsuperscript{66}.

The relevance of language and communication skill development was emphasized recently with the statement that, \textit{Skills such as problem solving, communications, interpersonal skills and critical and independent thinking should be fostered in engineering education, not just because they are qualities that employers look for but because they should be part of any tertiary education}\textsuperscript{67}.

\textbf{1.5.3 Teamwork}

The third factor among workplace competences is ‘teamwork’. No one is an island and no activity is independent. World has already converged into a global village. Everything is undertaken as a team where experts in various fields can interact and thus a corporate activity can be easily undertaken. Hence, every co-worker should be adaptable and flexible to work together in any situation. In real life, many people find it difficult to accommodate another. “Teamwork involves working in groups to solve problems. To work effectively in teams one must be willing to listen to and respect the team members’ ideas and views. In any teamwork, there is possibility of differences among the members. When involved in a difference of opinion, one should analyze the situation and determine how to compromise to achieve the overall goal of the team. All engineers need to have some negotiation skills for effective teamwork”\textsuperscript{68}.

Of the many suggestions to improve the employability of the engineering graduate, collaboration between the academy and industry is found stressed more in the research literature.
1.6 IQ Tests: Theories Interpreting Human Intelligence

A person’s ability to perceive, identify, and manage based on his/her skills provides the basis for many social and emotional competencies that have become important for one’s success in almost any job. As the pace of change has been increasing and the industry makes ever greater demands on a person’s cognitive, emotional and physical resources, the set of abilities have become increasingly important. A good amount of research is being carried out from clinical, academic and workplace perspectives evolving many theories.

“There have been two main theories which appeared in the 20th century and which were an attempt to interpret human differences and to design educational models around these differences. Learning Styles Theory which has its roots in the psychoanalytical community and Multiple Intelligences Theory are the fruits of cognitive science”, as expressed by Silver, et al.69 As Berman puts it, “IQ tests were developed by Binet and were used to assess the children’s potential in school”.70 The main problem with these standardized tests is that they focus on two intelligences only viz. linguistic intelligence and logical-mathematical intelligence, which have been always regarded as ‘scholastic’ intelligences. Traditional IQ assessment methods have given way to IQ test to bring out Multiple Intelligences of the assessed.

1.6.1 Intelligence Measuring Instruments

In the 1940s, the Ohio State Leadership Studies, under the direction of Hemphill71, focused their research on aspects of effective leadership. More specifically, this research suggested that leaders who are able to establish "mutual trust, respect, and a certain warmth and rapport" with members of their group will be more effective. At about the same time, the Office of Strategic Services developed a process of
assessment based on the earlier work of Murray\textsuperscript{72} that included the evaluation of non-cognitive as well as cognitive abilities. This process evolved into the "assessment center," which was first used in the private sector at AT&T in 1956\textsuperscript{73}. Many of the dimensions measured in assessment centers then and now involve social and emotional competencies such as communication, sensitivity, initiative, and interpersonal skills.

In the 20th century, innovators like Maria Montessori and John Dewy evolved systems of instruction based upon multiple-intelligences like techniques, including Montessori’s tactile letters and other self-paced materials, and Dewey’s vision of the classroom as a microcosm of society.

The traditional concept of intelligence limits the human capacities in a very narrow scale. Intelligence is not a linear concept that is always measured by IQ tests. Intelligence is so wide that it cannot be measured in this way\textsuperscript{74}. Therefore, there were alternative theories of intelligence which appeared to change this traditional concept of intelligence. White et al. stated that “They have been popular in the educational circles. These theories share something in common; they assert that human beings exhibit intelligent behaviour in a wide variety of ways. People are not simply ‘smart’ or ‘dumb’. They vary in their intellectual strength depending on the context in which they are working”. \textsuperscript{75}

1.6.2 Differential Aptitude Tests (DAT)

Aptitudes represent a fund of information and skills acquired by individuals over time. “Aptitude refers to a specific ability such as carrying out arithmetical calculations or recalling facts from information that has been read.” “Aptitudes form as a result of the interaction between individual characteristics and learning opportunities in the environment.” According to Vosloo et al.\textsuperscript{76} “Aptitudes are used to predict
variables such as future success in a given career which requires certain abilities.”

When considering the academic merits of an entry level engineer’s potential, it is necessary to determine not only his/her specific aptitude but also his or her skills level. The industry in general and the IT industry in specific, has made it mandatory for the entry level engineers to undergo a series of tests for identifying their employability skills.

The Differential Aptitude Tests known by the abbreviation DAT are the latest genre of the career aptitude tests. DAT is designed in such a manner that it is capable of testing all aspects of personality and identify the strength and weakness of a person. Pennock-Roman\textsuperscript{77} states that, “Hailed as one of the most comprehensive multiple ability batteries, Forms A and B of the DAT were originally developed in 1947 to measure the aptitudes of students from Grade 8 through to Grade 12 for the purpose of vocational guidance. Rather than measuring school learning, the tests were \textit{designed to measure intellectual abilities} independent of the content of school subjects.

As de Lemos\textsuperscript{78} observes, “Since their initial development, the DAT have been revised and re-standardized several times. In addition to vocational counseling with school students, they have been used with young adults for vocational guidance and personnel selection.”

1.7 Remedial Measures – Finishing School and Collaboration

Engineering graduates who are the potential candidates for the industry must have been already trained in their hard skills and the respective institutions must have imparted the required technical fundamentals, which definitely have to be reviewed and revised periodically with the implementation of thorough revamping and modifications in the respective areas. Hence, more attention must be
given to the training in soft skills which might not be properly attended at the institution level. More over, the areas of interaction between industry and the institutions also might not be well attended. Hence, Finishing School Program and Collaboration are prescribed world wide as remedial measures to bridge the skills gap among engineering graduates.

1.7.1 Finishing School Program

Finishing School Program enhances employability of fresh graduates and prepares them for induction into the IT industry. It is aimed to impart the relevant mix of soft and technical skills and orientation to industry culture.\textsuperscript{79} The objective of the finishing school program is to achieve a notable impact on productivity policy that may have to address the stock of skills gap (lack of skills across the workforce) in addition to focusing on improvements to the flow of skills, from new entrants to the labour market. Consideration should be given to a national qualifications and credit framework, encompassing the entire education system. Such a system would support work-based learning and ease progression for individuals throughout lifelong learning.

1.7.2 Academy-Industry Collaboration

The term ‘Dichotomy’ is found used as a synonym to collaboration. Colleges and Universities have a constant look at tomorrow's business people together with great access to resources while the Industry has the need and the drive to get things done - creating an opportunity for the Engineering graduates to work. In this way, the academic institutions contribute to the development of industries and technology. "In the developed world, universities have a long history of contributing to industry and the economy in a variety of ways. The American National Academy of Engineering, in their assessment of the contributions of academic research to the performance of industry sector, discovered that
there has been a growing recognition of the importance of Universities and academic research to industrial innovation and performance. The collaboration between the academy and the industry is imperative and inevitable as well. The means and modes of collaboration are many.

1.7.2.1 Collaboration: Means and Modes

Collaboration between industry and academia can be in different ways that may include

1) direct hires of students, graduates, and faculty;
2) temporary exchanges of researchers;
3) university/faculty consultancies;
4) joint research involving industry and academic scientists and engineers; industry-sponsored research contracts and grants;
5) a variety of institutional mechanisms at universities (e.g., research centers, consortia, industrial liaison programs);
6) publications;
7) conferences; and
8) short courses.

Industry stakeholders are, in many cases, made members of university curriculum advisory board. Interaction with the world of work, especially business and industry, is increasingly seen world-wide as a valuable component of science and technology education. Lack of collaboration and its subsequent dismay also is noticed in the literature.

Not far back, but in 2007, Krishna from India, in one of his articles, lamented about the “poor and inadequate supply of technical manpower in their growing IT industry and worries about the negative effect it is going to have on this industry. He pointed out that only 25% of India’s annual technical graduates are employable in the IT industry and that the
university supplies far less than adequate manpower in certain critical need areas in the industry. He blamed this circumstance on the poor partnership between academia and industry. He calls on the industry to invest in building a resource pool of skilled technical professionals in partnership with Academia, because the responsibility is not on the education system alone.¹

Technologically developed countries in the world invest heavily in technological innovation through partnership with academia. Many examples are available. The National Academy of Engineers (NAE) report² showed how the Network systems and Communications industry drew from academic research for fundamental innovations, as well as using universities as test beds for new networking concepts that have provided the underpinnings of the Internet, the World Wide Web, and ecommerce.

### 1.7.2.2 Collaboration: National Efforts in India

In view of a larger turn over of Engineering graduates with a majority of them suffering from skills gap, India need to take suitable measures. A report published in May 2010 from the Secretariat of the Organisation for Economic Cooperation and Development (OECD), gave a statistical account of the status of the Engineering and IT related human capital of India with evidence from a publication of the Government of India, along with a remark confirming the persistence of the skills gap between the competency of the entry level engineering graduates and the expectations of the IT industry in India. According the OECD report, “India has a very large pool of labour, with nearly 60% of its population between the ages of 15-59, and more than 50% below the age of 25. Despite the lack of universal literacy, the Indian Education system creates a large number of IT professionals. Indian curricula are heavily based on science, mathematics and engineering, creating a suitable environment for producing IT professionals.”³
Despite the developmental progress in India, the Indian National Academy of Engineering\textsuperscript{84} (INAЕ) called for an enhanced interaction between the academia and industry to the level obtainable in technologically developed countries where industry collaboration plays a vital role. The Australian Academy of Technological Sciences and Engineering (ATSE) has, over the past year, conducted an extensive strategic review and planning exercise which included a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis and identified a number of important issues facing the Academy, one of which includes: “How to develop and promulgate Academy policies on key issues in the application of science, technology and engineering”.

There are ample evidences in literature, which confirm the fact that both developed and developing nations are constantly looking inwards to see how they can improve their engineering education in order to be better able to solve their current problems and at the same time prepare for the future. Theoretical approach insists on collaboration between academy and industry all throughout. But in practice the concept of collaboration is either missing or lacking. The strength of IT professionals is found less than the strength of graduates produced in India as per statistics released for the years from 2003 to 2008 and the details are given in the following table.
Table 1.1   Indian IT labour supply: IT software and services

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</thead>
<tbody>
<tr>
<td>1) Degree (four years)</td>
<td>139 000</td>
<td>170 000</td>
<td>222 000</td>
<td>270 000</td>
<td>290 000</td>
</tr>
<tr>
<td>2) Diploma &amp; MCA (three years)</td>
<td>177 000</td>
<td>195 000</td>
<td>219 000</td>
<td>231 000</td>
<td>246 000</td>
</tr>
<tr>
<td>3) No. of engineering graduates of which:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1) Engineering IT graduates (degree)</td>
<td>84 000</td>
<td>102 000</td>
<td>133 000</td>
<td>162 000</td>
<td>180 000</td>
</tr>
<tr>
<td>3.2) Engineering IT graduates (diploma)</td>
<td>95 000</td>
<td>99 000</td>
<td>113 000</td>
<td>118 000</td>
<td>123 000</td>
</tr>
<tr>
<td><strong>No of IT professionals</strong></td>
<td>179 000</td>
<td>201 000</td>
<td>246 000</td>
<td>280 000</td>
<td>303 000</td>
</tr>
</tbody>
</table>

Note: ** IT professionals include Computer Science, Electronic and Telecom professionals. Figures do not include employees in the hardware sector. Source: NASSCOM (2006), Knowledge Professionals Fact Sheet.

Table 1.1 shows that there is a gap between the output number of Engineering graduates and the number of IT professionals under each year spanning from 2003 to 2008. It depicts the labour supply status of the Indian IT sector. Even at current levels of employability, India has the largest pool of suitable offshore talent, accounting for 28% of the total suitable pool available across all offshore destinations. NASSCOM estimated a demand for 850 000 IT and 1.4 million ITeS professionals in the 2009-10 financial year, outstripping new supply. However, Indian education tends to underestimate the importance of creative activities, and there is always a mismatch between the knowledge and real practice amongst the professional labour force.

One of the recent surveys undertaken by the The FICCI-CVOTER 2010 Survey of decision makers of India Inc., including CEOs, MDs, Human Resource Directors, et al., reiterates the growing importance of soft skills and vocational training in furthering career prospects of the present and future breed of professionals. The Survey Report further stated that, “So an IT career aspirant today does not only need to know how to write a hard-to-crack C++ program but should also be able to work...
well with others, know how to lead a team, prepare a quick power point presentation and in general a good communication skill besides non-technical skills expected of, by the industry."

1.8 Summary

Economic growth in India has, in the last few years, picked up considerable momentum with services and recently, the manufacturing sector showing a great deal of buoyancy. While the jury is out on whether the country can sustain a GDP growth of 9% per annum, it is generally agreed that much greater attention would have to be paid to the area of skill development.87

In a highly competitive world, being academically sound might just not be sufficient for graduates. According to experts, accomplishing a number of pre-requisites starting with communication, aptitude and presentation skills go a long way in making the graduates employable and industry-ready. The competence requirements of engineers are changing and increasing rapidly. Therefore, this challenges engineering education in general. A process of structural transformation is also under way in a post modern society. Fast growth of information society, in this regard, is affecting more the working life competence needs. Continuous competence development forms the basis for good employment and positive career prospects.

While highlighting the status of employability of Indian graduate engineers, Mr. Amit Bansal, CEO, PurpleLeap, from Hyderabad says, "The times right now are very challenging. The global economic crisis is expected to lead to a dramatic increase in the number of people joining the ranks of the unemployed. The task becomes more daunting for entry-level professionals especially if they are found lacking in the basic skills necessary for employability. The Industry/Companies today want candidates who not only possess the critical skills but are ready to start
work from day one, because mostly nobody wants to spend time and money on training the new entrants. All of this means that students will need to do all that they can work on their skills and be industry ready. Just going to college and finishing their studies is evidently not enough. The implied meaning is that the graduate engineers in order to satisfy the industry needs, should possess soft skills and competencies.

Engineering Institutions of higher learning play an important role in developing and enhancing human capital for the IT industry. The skills gap is a reality leaving a majority of the entry level engineering graduates to the fate of unemployment or underemployment. One of the ways available to bridge the skills gap is for institutions of higher learning to reach out to industries to better understand their workforce requirements. This will enable institutions of higher learning to design new curriculum and redesign existing ones to be market-driven, placing emphasis on creativity, innovation and other enabling skills. Such collaboration between Engineering institutions and industries with initiatives from the government can ensure a supply of engineering workforce matching the market requirements.

As the world moves towards a more globalised economy, the importance of innovation in addition to economic and infrastructural development as a driver of sustainable economic growth cannot be underestimated. Innovation which requires the involvement of engineers at various stages, increases competitiveness, which in turn leads to employment generation and wealth creation. The engineering graduates at the entry level of recruitment need to be equipped with non-technical skills besides their technical qualifications, in order to meet the challenging needs of the industry. The Academy should shoulder the task of bridging the gap of the entry level engineers enhancing the potential of their employability.
1.9 Notes and References


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