Enhancing Professional and Soft Skills of the Indian Engineering Graduates

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Abstract

In the 21st century, the engineering education has to contribute to the knowledge and human capital development. The globalized economy demands high quality professional skills/hard skills and soft skills in the engineering graduates to meet the needs of the fast growing global industries. Most of advanced countries focus not only on the hard skills like design, manufacturing, and maintenance, but also on the soft skills like communication, interpersonal relations, and high performing team development etc. In India many engineering programs need to be evaluated against the needs of the fast growing technology. It is found that most of the programs need to be improved by introducing many industry relevant advanced courses and electives. In the case of soft skills development, the graduates need training in the soft skills to get needed expertise to perform in the various units of MNCs.

Keywords: Hard skills, soft skills, industry relevant programs, faculty training for skill development.

1. Introduction

India opened its economy to global investors (foreign institutional investors and foreign direct investors) in 1991. Engineering education has to ensure quality assurance to ensure that acceptable standards of education, scholarship and quality infrastructure. Now India produces around 1.6 million engineers every year, but only 25% of them are employable. Every year around 100,000 seats in various engineering colleges are not filled. Around 25% colleges do not get the sufficient students against sanctioned intake. Only 15% of the graduates get appropriate and high end jobs. Most of institutes employ raw graduates as faculty members and offer very low salary. They are not given any useful professional training required for the teaching job. These young faculty members would not stay even beyond one academic year. Under these circumstances, the engineering students may not get any in depth professional skills and competence. In the knowledge based economy, there is a need for professional skills and soft skills for the engineering graduates who are planning to enter in to the jobs in the corporate. Most of the colleges do not update the curricula and the resources to meet the skills development programs. They do not even maintain good relationships with the local companies. All these affect the performances of the engineering graduates. The engineering universities in China, Korea and Japan have planned outstanding skill development programs and meet the needs of their industries. India has globalized its economy 25 years back. Toyota and Ford Company closed their manufacturing units in Australia for want of skilled workers and engineers, but they established new production centers in India due to the availability of abundant engineering graduates and technicians.

Many multinational companies (MNCs) have established many manufacturing companies for export. Now they plan many high-end design and manufacturing ventures which need industry-ready engineers.

According to Woods, Felder and Stice (2000) “Process skills are soft skills used in the application of knowledge. Further, they stated that the degree to which students develop these skills determines how they solve problems, write reports, function in teams, self-assess and do performance reviews of others, go about learning new knowledge manage stress when they have to cope with change. Barbara Climatti (2016) stated that soft skills used to indicate personal transversal competencies such as social attitudes, language and communication capability, friendliness and ability to work in a team and other personality traits that characterize relationships between people. Soft skills are traditionally considered complementary of hard skills, which are abilities to perform a certain type of task or activity. According to her soft skills are strategic to be successful in personal and professional life then are essential for a graduate when he/she tries to obtain any kind of job. Enterprises generally hire new employees taking more in consideration their soft skills than hard skills. Enterprises need to create good and effective teams and collaborative working atmosphere.

2. Objectives of Research

Considering the growing needs of the fast growing MNCs in India, and new initiative “Make in India”, this research has been undertaken with the following objectives:

- Identify various professional skills that are prescribed by various accrediting agencies
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- Review various global development processes to inculcate various skills
- Review various initiatives taken by the global universities to develop skills in the engineering students
- Identify the roles of educational administrators in creating educational environment for planning and inculcating the needed professional skills in the engineering graduates
- Briefly describe various initiatives taken by the researcher at the National Institute of Technical Teachers Training and Research (NITTTR), Chennai to develop professional skills in the engineering faculty
- Suggest implementable strategies for developing various hard and soft skills in the engineering students by the engineering colleges and polytechnics

3. Definitions

Definitions, elaborations, and explanations of the terms used in this paper are presented in the following section.

Ability/Capability
Ability is the power to perform a particular feat at a particular time. The person can perform the task now no further training is required (Reber, 1995 and Sternberg, 1998).

Skill
- All skills are learned, or are capable of being learned and developed (and observable) performance of particular types of activity and task.
- Skills are behaviors that are carried out when knowledge, attitudes and personality traits are not put in practice.
- They constitute the corpus of knowledge, procedures, competencies, aptitudes and attitudes that are needed to carry out various activities to a certain degree of quality and effectiveness, and in independent and flexible manner.
- Skill mainly refers to the integration of knowledge, skills, and attitude (KSA).
- Knowledge consists of the outcomes of perceptive and conceptual processes such as attention, selection, symbolization, codification/decodification, reflection, and evaluation.
- Execution of competence, the outcomes of a psychomotor process that enables individuals to give clear responses, and possibly to offer a tangible product that may be observed and assessed by another person.
- Attitudes are the products of emotional responses to events and other specific objects.
- Skills are not stable characteristics (traits), but rather the demonstration of appropriate performance in particular contextual/situational conditions.
- Skill acquisition, development and expression (or inhibition) depend at all times both on personal characteristics, such as contextual or situational characteristics, and on the dynamic interaction between both fields (personal and situational).
- An engineering graduate to demonstrate skill in a job, function or role, s/he not only needs to master a series of conceptual, procedural and attitudinal knowledge.

Competence
Competencies are structured around demands and tasks. Fulfilling complex demands and tasks require not only knowledge and skills, but also involve strategies and routines needed to apply the knowledge and skills, as well as appropriate emotions and attitudes, and effective management of these components (Rychen and Salganik, 2000).

<table>
<thead>
<tr>
<th>Competences</th>
<th>Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refers to the ability to meet demands of a high degree of complexity action systems, the term knowledge applies to facts or ideas acquired by study, investigation, observation, or experience and refers to a body of information that is understood.</td>
<td>Designates the ability to use one’s knowledge with relative ease to perform relatively simple tasks.</td>
</tr>
</tbody>
</table>

The engineering graduates acquire competencies through investigation, analysis, problem-solving, design, creative product development, testing, and research. They predominantly acquire skills through workshop practices, laboratory works, field works, camps, industrial training, group discussions, and seminars.

Holistic Model of Competencies
Spans a range of human processes and actions and incorporates cognitive, psychomotor, and affective,
as well as ethical dimension, implying moral agency and desire.
• Broad than knowledge or skills, and are acquired in an on-going, lifelong learning process across the whole range of personal, social and political contexts.
• Strongly value-dependent because of competence in the real world.

Key Competences
Refer to those generic skills that warrant special recognition for their outstanding importance and applicability to the various areas of human life (educational, occupational, personal and social).

Soft Skills
Intra and interpersonal(social-emotional) skills, essential for personal development, social participation, and workplace success are termed as soft skills.
Includes skills such as communication, ability to work on multidisciplinary teams, adoptability etc. These soft skills should be distinguished from technical or ‘hard skills’.

Generic Skills
Applicable and useful in various contexts; can be transferred among different work occupations; includes soft skills and additional abilities, such as literacy, numeracy, technology use etc.

Basic Skills
Sub-group of generic or key competencies that are instrumentally essential in a given culture for every person and job and continue learning.
Examples of basic skills are basic arithmetical calculations, reading, and writing, and electronic information communication technologies (EICT).

• Changes forced by the fragile world economy
• Graduate and professional mobility
• Use of communications and instructional technology
• Increasingly loud voice of the social imperative Challenges are due to globalization’s impact on engineering education.

ABET (2012) Student Learning Outcomes
The followings are considered for evaluating the achievement of the engineering graduates and considered for accrediting the program by the Accrediting Bureau of Engineering and Technology (ABET) of USA. India has signed the Washington Accord and National Board of Accreditation (NBA) would evaluate the programs and accredit them.

Hard Skills
• An ability to apply knowledge of mathematics, science and engineering (3.a)
• An ability to design and conduct experiments, as well as to analyze and interpret data (3.b)
• An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability (3.c)
• An ability to identify, formulate, and solve engineering problems (3.e)
• An ability to use the techniques, skills, and modern engineering problems (3.k)

Research on the hard skills of the engineering graduates in Civil Engineering [Tamilarasu and Thanikachalam (2004), Mathew and Thanikachalam (2013)], Mechanical engineering [(Sivanesan and Thanikachalam, (2009) Subbaraj and Thanikachalam (2013)] Computer Science and Engineering, (Srividhya and Thanikachalam (2014) postgraduate programs in Embedded Technology Systems (Sheebarani and Thanikachalam 2012 & 2013 have been completed. Most of the engineering programs need thorough revision to offer industry relevant courses [(Kurinchi and Tahnikachalam (2014)]. India is very much lagging in theglobalization of engineering programs [(Anita and Thanikachalam (2011)]. There is an urgent need for institutional development [(Sujatha and Thanikachalam (2013)]. The state engineering universities and deemed to be universities have to evaluate all the existing programs and improve them strategically.

Professional Skills
• An ability to function on multi-disciplinary teams (3.d)
• An understanding of professional and ethical responsibility (3.f)
• An ability to communicate effectively (3.g)

Awareness Skills (Larry, Mary, and Jack,2005)
• The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and social context (3.h)
• A recognition of the need for, and an ability to engage in life-long learning (3.i)
• A knowledge to use the techniques, skills, and modern engineering tools necessary for engineering practice (3.j)

Barbara Cimatti (2016) stated that social identity is important for soft skills because it leads to:
Self-awareness  
Managing self  
Communication  
Empathy  
Effective dialogue across differences

All these skills are more important to the engineering graduates to become successful managers.

According to Chinotti (2015) the most required skills required for employment are:

- Verbal communication
- Report writing
- Team working
- Making decisions and problem-solving
- Planning and organization
- Ability of influencing
- Information processing
- Computer software use
- Analysis of data
- Technical knowledge

**Socio-Emotional Competence**

Increasing interest in Emotional Intelligence (EI) has contributed to the development of emotional skills and its extension to soft skills. Carolyn Saarni (1999) listed the following eight emotions:

- Awareness of one’s own emotions
- The ability to discern and understand other’s emotions
- The ability to use the vocabulary of emotion and expansion
- Capacity for empathetic involvement
- The ability to differentiate internal subjective emotional expression
- Capacity for adaptive coping with adverse emotions and distressing circumstances

Collaborative for Academic, Social and Emotional Learning (CASEL), a research body of international standing in school programs on ‘Social-Emotional Education’, has drawn up a list of socio-emotional skills and competencies that fall under four headings:

- Knowing oneself and other people [e.g. to recognize and label one’s own feeling]
- Taking responsible decisions [e.g. Appropriate emotional regulation]
- Caring for other people [Key factor: Empathy]
- Knowing how to behave [a group including verbal and non-verbal communications, the management of interpersonal relationships, and negotiating]

**Frameworks**

The lists of generic skills have six common elements (NCVER, 2003):

- Basic/fundamental skills [Literacy, using numbers, using technology]
- People-related skills [Communication, interpersonal, teamwork, customer service skills]
- Conceptual/thinking [Collecting and organizing information, problem-solving, planning and organizing, learning–to-learn skills, thinking innovatively and creatively, systems thinking]
- Personal skills and attributes [Being responsible, resourceful, flexible, able to manage own time, having self-esteem]
- Skills related to the business world [Innovation skills, enterprise skills]
- Skills related to the community [Civic or citizenship knowledge and skills]

<table>
<thead>
<tr>
<th>Employer organization</th>
<th>Workplaces</th>
<th>DeSeCo Project of OECD</th>
</tr>
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<tbody>
<tr>
<td>Through interviews with and focus groups of employer representatives and reviews of other schemes</td>
<td>Analysis of the skills enacted by practitioners in workplaces</td>
<td>The discipline-based approach through academics.</td>
</tr>
</tbody>
</table>

5. **The Engineer of 2020**

Most of the global universities vigorously develop projects for skill development to meet the needs of the industries of 2020. The models developed by various faculty members and researchers are presented in the following Table: 1.
<table>
<thead>
<tr>
<th>Model</th>
<th>Originators</th>
<th>Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EWB : Engineers Without Borders</strong></td>
<td>Prof. Bernard Amadei, The university of Colorado at Boulder, USA</td>
<td>Helping disadvantaged communities improve their quality of life by implementing environmentally and economically sustainable engineering projects while developing internationally responsible engineering students; A means of introducing open-ended problem solving in conjunction with developing asynthesis, analysis, teamwork, communication business and entrepreneurial skills.</td>
</tr>
<tr>
<td>Designing systems</td>
<td>Dym et al. (2005), Sheppard and Jenison, (1997)</td>
<td>The design makes up an important part of the engineering education process. Engineering students must be taught to focus both on designing systems and on attaining a broader understanding of their work’s impact on their communities and their surroundings.</td>
</tr>
<tr>
<td>Emotional intelligence</td>
<td>Scott and Yates (2002)</td>
<td>The observed lack of soft skills in engineering graduates is the concept of emotional intelligence. Emotional intelligence dictates the quality of an individual’s human interactions. Emotional intelligence directly affects a person’s leadership skills, teamwork ability, stress tolerance and judgment. The importance emotional intelligence to an engineer’s success places pressure on engineering curricula to foster this aspect in graduates and produce engineers equipped with an adequate degree of emotional intelligence in order to perform effectively as professionals.</td>
</tr>
<tr>
<td>Professional Skills</td>
<td>Lohman et al. (2006)</td>
<td>Formulated a conceptual model for the success of engineers on a transnational basis. Ability to speak a second language constituted an important component of an engineer’s skill set. Cultivate engineer’s multilingual capabilities during their undergraduate studies.</td>
</tr>
<tr>
<td>Social and environmental responsibility</td>
<td>Conlon (2008)</td>
<td>Social and environmental responsibility had increasingly become an important part of the engineering profession. Must be aware of the impact of their solutions, not just on their employees and their clients, but also on the environment and society as a whole.</td>
</tr>
<tr>
<td>Technical skills</td>
<td>Shuman et al. (2005)</td>
<td>While technical skills remain a prominent component of all engineers skill set, soft skills have become equally important.</td>
</tr>
<tr>
<td>Soft skills</td>
<td>Beck and Sanders (1998), Beder (1999), Balaji and Somashekar (2009)</td>
<td>Found that employers are more likely to recruit applicants who showed a higher level of soft skills as opposed to those who only exhibited a high level of technical ability (hard skills)</td>
</tr>
<tr>
<td>Team skills and Leadership skills</td>
<td>Farr and Brazil (2009)</td>
<td>Team skills and leadership skills played an important role in American engineer’s career</td>
</tr>
<tr>
<td>Multicultural, multidisciplinary environment</td>
<td>Nair et al. (2009)</td>
<td>Engaging engineers in community –related activities helped bolster a variety of soft skills.</td>
</tr>
<tr>
<td>Community-related activities</td>
<td>Reamer (2002)</td>
<td>Language and communication skills form an integral part of engineer’s abilities. Verbal, written and presentation skills Utilize new technologies to communicate on a global scale</td>
</tr>
</tbody>
</table>

**Table-1**
Firms operating on international levels require that their engineers be able to communicate across cultures. Multilingual skills are viewed as an asset in the modern workplace.

### Interpersonal skills
Laker and Powell (2011) Defined soft skills as “Interpersonal skills such as one’s ability to manage oneself as well as interpersonal skills such as how one handles one’s interactions with others.

### Leadership skills
Farr and Brazil (2009) Team skills and leadership skills play an important role in American engineer’s career. Engineers must be capable of working not just an individual basis, but also as members and leaders of teams. Leadership and team skills relate directly to an individual’s ability to deal with other people.

### Engineers with Business skills
Martin et al. (2005), Brich (2007) Required to attain business skills in order to sustain competitive advantage on a professional and corporate level. Increasing global completion has translated into the need for more rounded engineering professionals who can function in global, social, financial, technical and commercial contexts. Engineers must be able to connect the business world with the scientific community in order to drive innovation.

### Managerial skills

### Social and global contexts
Fuchs (2006) Recommended that educational institutions should re-focus the course work required of engineering students to allow them to work more effectively within social and global contexts.

### Converged and Global Set of Competencies
Karim Naser (2014) UNESCO partnered with World Bank and created the Global Initiative for Quality Assurance. • Mobility for graduates • Compatibility of programs and of graduates • Recognition of degrees • Benchmarks, standards, and metrics selection • Agreement on terminology • Institutional specifics and regional-level contexts • Emergence of non-traditional institutions and programs • Internal-external QA systems/policies • Reciprocity and mutual recognition of accreditation decisions • Legitimacy of accreditation agencies • Quality assurance in transnational education and cross borders


The projects in skill development are presented in Table 2.

<table>
<thead>
<tr>
<th>Project</th>
<th>Organization/ institution</th>
<th>Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department of Engineering Education (2002)</td>
<td>Purdue University, Lafayette, Indiana, USA, Virginia Tech, USA</td>
<td>Interdisciplinary department planned engineering education program</td>
</tr>
<tr>
<td>Building Engineering Student Team Effectiveness and Management Systems</td>
<td>Clark School of Engineering, University of Maryland Supported by National</td>
<td>Modular team training program can be adopted by the engineering faculty from various schools; modules: introductory, intermediate, and advanced; Major team skill domains: personal, interpersonal, project</td>
</tr>
<tr>
<td>(BESTEAMS)</td>
<td>Science Foundation management</td>
<td>(BESTEAMS)</td>
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<td>------------------------------------</td>
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<td>------------------------------------</td>
</tr>
<tr>
<td><strong>EPICS</strong></td>
<td>Oakes et al. (2002)Purdue University, Lafayette, Indiana, USA Service Learning in Engineering provides realistic teaming activities, with all the complexities experienced by a product design team. Some computer-generated simulations also can be highly realistic and very complex. Center for creative Leadership’s COLOR simulation.</td>
<td><strong>ESW: Engineers for Sustainable World (Engineers without Frontiers-USA)</strong></td>
</tr>
<tr>
<td>College of Engineering, Cornell University, Dr. S. Krishna, S. Athreya and Regina Clewlow, 2001)</td>
<td>Engineers and community members can work together to identify and solve technology-based problems, employing solutions that can be locally sustained, leading to an improved quality of life.</td>
<td>College of Engineering, Purdue University, Lafayette, Indiana, USA</td>
</tr>
<tr>
<td><strong>EGHP: Engineering Global Leadership Honors Program</strong></td>
<td>University of Michigan Global concentration in engineering with an initial focus on China, the United Kingdom, and Mexico; flexible framework enables all disciplines to participate; requires international experience, global engineering course content and cross-cultural course for engineers on global understanding; better prepares engineers with not only appropriate technical skills, but also the cross-cultural skills</td>
<td>Iowa State University and the Universities of Dayton and Seattle</td>
</tr>
<tr>
<td><strong>ETHOS: Engineers in Technical, Humanitarian Opportunities of Service Learning</strong></td>
<td>To help the students gain an awareness of social and cultural fabric of poorest of the world and perform design research focused on improving the ability of these individuals to meet basic needs.</td>
<td>Accredits European engineering programs Supported by France and Germany (ENAE 2008) Similar to ABET and IEA</td>
</tr>
<tr>
<td><strong>EUR-ACE</strong></td>
<td>Provides 6 main categories for engineering graduate skills as follows: 1. Knowledge and understanding 2. Engineering Analysis 3. Engineering Design 4. Investigations 5. Engineering Practice 6. Transferable Skills</td>
<td>Purdue University (Hileman et al. 2004) 18 months program; developed in partnership with Karlsruhe (Germany) and Shanghai Jian Tong (China) Universities; integrates language education, cultural orientation, three-month domestic and three months international internship orientation; two semester face-to-face multinational design team project with one semester abroad and one semester at home; bilateral program involves equal numbers of students from each university participating in the paired exchanges. The Engineering education Department organizes “Global Engineering Course” for the senior students involving global faculty using video conference method.</td>
</tr>
</tbody>
</table>
9. Individual and Teamwork
10. Communication
11. Project Management
12. Finance, and Lifelong Learning

**IVDS: International Virtual Design Studio**
Union College, and Mideast Technical University (METU), Ankara, Turkey and Queen’s University, Kingston, Ontario, Canada
Training engineers to be well prepared to collaborate with their colleagues around the world; to work effectively in geographically distributed, multicultural teams; to develop skills among students to better function in the emerging global environment in today’s workplace.
Outcome: Provide international culture interaction, teambuilding, communication, creative thinking, and project management.
Each IVDS team had four to six students and two or three from each institution.

**VR: Virtual Reality MEMS across the Globe**
Potential to have a major impact on engineering education by permitting students to explore environments that would be otherwise inaccessible. Facilitate teaming on an international and therefore multicultural level. Addresses educational collaboration in the virtual environment, testing and refining it at the institutional level between institutions and across national boundaries.

**GEC: Global Engineering College**
Northern Arizona, USA
Language and Engineering Faculty are combining to utilize virtual reality to develop a pilot “Global Engineering College” Injects international perspectives throughout the curriculum by leveraging technological developments to create a ‘virtual’ engineering college.

**RIRI: Receiving, Inquiring, Refining, and Integrating**
Lifelong learning:
- Demonstrate reading, writing, and speaking skills;
- Demonstrate an awareness of what needs to be learned;
- Follow a learning plan;
- Identify, retrieve and organize information;
- Understand and remember new information;
- Demonstrate critical thinking skills; and
- Reflect on one’s own understanding.

**UK’s Royal Academy of Engineering (2007)**
Educating engineers for the 21st Century: University engineering courses emphasized that “University courses need redesigning for the modern economy” “Industry wants graduates with more experience of problem-solving, group ‘design and make’ projects, and applying theory to real industrial problems. Students need opportunities to work in genuine industrial environments through work placements and projects and university staff need to be able to develop new teaching materials with input from companies, learning from the success of academic-industrial links’

7. Synthesis of the literature
Literature survey clearly establishes the in-depth focus shown by all leading nations on the skill development of engineering graduates. This is one of the reasons for high-quality production in these countries. This leads to easy accreditation of the
graduate programs. The employers get the maximum benefit of industry ready graduates which reduce the initial training expenditure.

The following are the most significant synthesis from the above literature survey:
Most of the industrialized countries focus on the needed competencies required for the global employment, hard and soft skills to undertake effective design, working in teams, managerial skills and business skills. The Indian educators have to incorporate these global trends in their planned activities.

CEOs (Dean/ Director/Principal/Vice- chancellor/ Registrar/ Chairman) Role in Creating Conducive Educational Environment for Effective Skill Development

The CEOs are responsible for establishing needed conducive educational environment, facilitate the development of outstanding teams and encourage the excellence in all educational activities. Further, they have to establish various cells, centers and interdisciplinary departments and programs. Based on the discussion with more than 900 engineering faculty members in the last 20 years, the following roles are identified and presented:

- Facilitate the development of leaders in various educational activities like curriculum development, program implementation, research and consultancy works
- Prepare organizational design to provide appropriate structure for fast development
- Recruit qualified and experienced faculty members without bias
- Involve adjunct faculty from the industry and national labs
- Train the faculty members to plan emerging technology programs based on the emerging needs
- Reward the outstanding faculty members
- Fill all the sanctioned posts
- Establish centers for curriculum development, faculty development, and consultancy works, research under various schemes of UGC and AICTE and plan for sponsored projects under international development agencies
- Facilitate the establishment of affiliations with global institutions
- Support the engagement with MNCs to organize practice-linked programs
- Support study abroad programs
- Conduct orientation programs for the students to know the global competencies

- Integrate technology into engineering curriculum to match the emerging needs of the digital global industries
- Periodically assess the needs of new skills and sponsor the faculty to the training programs
- Develop global industry-focused programs in the emerging technology
- Evaluate the outcome and take appropriate decisions to accelerate the progress.
- Recognize the contribution of the key resource persons
- Permit the selected faculty members to participate in the global seminars
- Permit the faculty members for overseas in-service training programs through bilateral agreements when they are selected based on their application through proper channel
- Permit continuing education programs for the executives of companies
- Permit to plan overseas executive development programs
- Empower the outstanding faculty members in planning global seminars, conferences, workshops, bidding for the global projects, participating in the peripatetic seminars, continuing overseas training programs by taking the leave at their credit
- Delegate of authority to develop realistic financial proposal for bidding global development projects under International Development Agencies like Asian Development Bank, UNDP, UNESCO, World Bank etc.
- Decentralize the decision making with respect to planning executive development programs under various ministries of the government/private industries
- Communicate the letters of invitation for sending the technical and financial proposals for participation, bidding and undertaking sponsored programs
- Permit the outstanding publications in the journals and conferences
- Participate in the state sponsored programs
- Follows the ethical standards
- Eliminate corruption in all institutional activities

When the faculty is developed and motivated, then they can motivate the students. Most of the institutes do not follow ethics in recruiting the faculty or permitting them to participate in the overseas training programs. This results in poor performance of the students.
8. Faculty’s Professional Skills to be developed

The initiatives undertaken by the author are presented in Table-3.

<table>
<thead>
<tr>
<th>NITTTR Chennai Projects (1980-2011) under QIP Short-term Programs</th>
<th>Faculty’s Professional Skills to be Developed</th>
<th>Outcome</th>
<th>Underlying Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Textbooks for new curricula</td>
<td>3.a), 3.c), 3.d) 3.k) 3.f), 3.g), 3.h), 3.i) and 3.j)</td>
<td>New textbooks have been produced and published through reputed international publishers</td>
<td>Outstanding writing skills</td>
</tr>
<tr>
<td>Drawing Manual Development</td>
<td>3. a), 3.c), 3.d), 3.k), 3.f), 3.g), 3.h), 3.i) and 3.j).</td>
<td>New drawing manuals have been developed and published through refuted publishers</td>
<td>Creativity and writing skills</td>
</tr>
<tr>
<td>Item Bank</td>
<td>3. a), 3.b), 3.c), 3.d), 3.f), 3.g), 3.h), 3.i) and 3.j).</td>
<td>Item banks have been developed, edited and mass produced</td>
<td>Problem-solving and writing skills</td>
</tr>
<tr>
<td>Lab Manuals Development</td>
<td>3. a), 3.b), 3.c), 3.d), 3.e), 3.k), 3.h), and 3.g).</td>
<td>New lab manuals have been produced and published through reputed publishers</td>
<td>Critical thinking and writing skills</td>
</tr>
<tr>
<td>Industry Relevant Curriculum in Engineering</td>
<td>3.a), 3.e), 3.e), 3.k), 3.f), 3.g), and 3.j)</td>
<td>New curricula have been produced and got approved and implemented</td>
<td>Creativity, commitment for excellence, tolerance for disruption, lifelong learning, and fearless strategic planning</td>
</tr>
<tr>
<td>Internal Revenue Generation and Utilization</td>
<td>3. a), 3.b), 3.c), 3.d), 3.e), 3.f), 3.k), 3.g), 3.h), 3.i) and 3.j).</td>
<td>Expertise has been developed and many new development programs have been developed for the working professionals</td>
<td>Commitment to excellence, critical thinking, and problem-solving skills</td>
</tr>
<tr>
<td>Interdisciplinary Ph.D in Engineering Education</td>
<td>3.a), 3.b), 3.e), 3.d), 3.e), 3.k), 3.g), 3.i), 3.h), 3.i), and 3.j)</td>
<td>18 faculty members undergone interdisciplinary Ph.D program in the engineering education and they occupied CEOs position in the engineering colleges</td>
<td>Creativity, critical thinking, problem solving skills, achievement motivation, commitment for excellence and communication skills</td>
</tr>
<tr>
<td>Globalization of Engineering Education</td>
<td>3.a), 3.b), 3.d), 3.e), 3.k), 3.g), 3.i) and 3.j)</td>
<td>Many faculty members undergone the programs and a few got selected for international postings</td>
<td>Critical thinking, creativity, ethics, and fearless strategic planning</td>
</tr>
<tr>
<td>Leadership Development</td>
<td>3.e),3.e),3.g), 3.d), 3.f) and 3.j)</td>
<td>Majority of the faculty undergone this program and improved their leadership skills</td>
<td>Ethics, interpersonal relationships, and critical thinking</td>
</tr>
<tr>
<td>Interpersonal Relationships</td>
<td>3.e), 3.g), 3.d) 3.h) and 3.j)</td>
<td>Majority of the faculty developed excellent relationships with other members of the institute</td>
<td>Interpersonal relationships, ethics, and tolerance for disruption,</td>
</tr>
<tr>
<td>Institutional Development</td>
<td>3.b), 3.c), 3.g),3.d) and 3.j)</td>
<td>The senior faculty members who have undergone this program contributed to the institutional development.</td>
<td>Critical thinking, creativity, problem-solving skills, and lifelong learning.</td>
</tr>
<tr>
<td>Student Services</td>
<td>3.c), 3.e), 3.k) and 3.d)</td>
<td>Engineering students are motivated and developed to acquire professional skills</td>
<td>The faculty has been developed in the guiding, coaching and mentoring of the students.</td>
</tr>
</tbody>
</table>

All these initiatives yielded excellent results in developing skills in the engineering graduates. MNCs in the Southern region got highest benefits and continued to grow. The region has become very competitive in quality production and export.


The professional development projects undertaken by the author are presented in Table 4. Significant projects are Advanced Development of Engineering Faculty Experience (ADEFEx), Executive Development Seminars for the Global Participants (EDSGP), Human Resource Dynamics (HRD), and Research Seminars for Ph.D. Scholars (RSPhDS).

<table>
<thead>
<tr>
<th>Project</th>
<th>Participants</th>
<th>Skills</th>
<th>Predominant Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Program on Advanced Development of Engineering Faculty Experience (ADEFEx); Six weeks program</td>
<td>In-service teacher trainees, Overseas faculty members, and executives Participants are nominated by various developing countries in Asia, Africa, Europe, Central and South America and Oceania Government of India provided the funds</td>
<td>• Improving the decision-making skills, creativity, critical thinking, communication skills, achievement motivation, commitment for excellence, interpersonal relationships, tolerance for disruption, fearless strategic planning, ethics and leadership</td>
<td>3.d), 3.g), 3.h)</td>
</tr>
<tr>
<td>Executive Development Seminars for the Global Participants (EDSGP)</td>
<td>Global executive participants who are sponsored by various overseas governments under bilateral agreements for various medium-term programs which are funded by Government of India</td>
<td>• Problem-solving skills, communication skills, ethics, creativity, commitment to excellence, interpersonal skills, and fearless strategic planning and commitment to excellence.</td>
<td>3.d), 3.g) &amp; 3.h)</td>
</tr>
<tr>
<td>Human Resource Dynamics (HRD)</td>
<td>Postgraduate Engineering students in M.Tech (HRD)</td>
<td>• Problem-solving skills, creativity, communication skills, achievement motivation, ethics, interpersonal relationships.</td>
<td>3.e), 3.g) &amp; 3.h)</td>
</tr>
<tr>
<td>Research Seminars for Ph.D. scholars (RSPhDS)</td>
<td>In service Ph.D. scholars from the engineering colleges and polytechnic colleges</td>
<td>• Critical thinking, creativity, leadership, Problem solving skills, ethics, interpersonal skills, and achievement motivation.</td>
<td>3.a), 3.c), 3.g) &amp; 3.h)</td>
</tr>
</tbody>
</table>

The faculty members who attended the ADEFEx courses have continuously enriched the existing programs in the polytechnic colleges and engineering colleges. The engineering students from the well-designed programs got excellent jobs. Till now no company was closed for want of well-trained technicians or engineers.

The global programs attracted the attention of various developing countries and around 200 to 250 executives are being trained per year.

Most of the postgraduates (masters and doctorates) have been absorbed as directors, deans and principals in many engineering colleges. The postgraduates in HRD are absorbed by leading companies and around 25% of them are serving MNCs.

10. Suggested Strategies for Improving the Professional Skills of the Engineering Students

Based on the comparative studies, and the present status of the majority of the engineering colleges, the following strategies are presented to inculcate various skills of engineering graduates in Table 5. A few have been planned and implemented in the polytechnic colleges and yielded excellent results. Planning Community Development through Polytechnics was institutionalized in 1979–80. Now it is being implemented in about 1000 polytechnics in India with the assistance of Ministry of Human Resources.
<table>
<thead>
<tr>
<th>Strategy/Project</th>
<th>Professional Skills</th>
<th>Professional Skills</th>
<th>Initiative</th>
<th>Utility</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Planning Community Development through Engineering Students</strong></td>
<td>3.a, 3.b, 3.c, 3.d, 3.e, 3.f, 3.g, 3.h, 3.i, 3.j &amp; 3.k</td>
<td>Critical thinking, Problem solving, Analysis of the needs, Design of needed device, Prototype development, Testing, Improving, Incubation, Startup</td>
<td>Farm mechanization, Irrigation management, Farm power, Farm structures, Storage structures, Harvesting, Farm roads</td>
<td>Many graduates have started their own firms in manufacturing with the assistance of the state government organization, Leadership development, Confidence building, Business model building, achievement motivation</td>
</tr>
<tr>
<td><strong>Technology transfers to MSMEs</strong></td>
<td>3.a, 3.b, 3.c, 3.d, 3.e, 3.f, 3.g, 3.h, 3.i, 3.j &amp; 3.k</td>
<td>Evaluation of problems, investigation, analysis, problem solving, technology assessment, training the MSMEs, creating linkages</td>
<td>Energy management, Quality management, Cost reduction, Productivity improvement, Nondestructive testing</td>
<td>Creative solutions, business planning, strategies for a theory to practice, communication with the MSMEs, linkage mechanism, research, development, and diffusion.</td>
</tr>
<tr>
<td><strong>Assistance to Entrepreneurship Development of Engineers (1971-73)</strong></td>
<td>3.a, 3.b, 3.c, 3.d, 3.e, 3.f, 3.g, 3.h, 3.i, 3.j &amp; 3.k</td>
<td>Analysis of problems, selection of suitable business models, technology assessment, value engineering, financial analysis, supporting the incubation and startup.</td>
<td>Provide assistance to engineering graduates and permit the use of Workshop Equipment for trial production College of Engineering, Guindy, Chennai</td>
<td>Assistance in planning products, Designing the product Prototype development using the equipment of the college workshops, start-up, incubation, venture capitalist, business model</td>
</tr>
<tr>
<td><strong>Assistance to Executive Training of the Software Company (Cognizant Technologies, Chennai) through M.Tech (HRD) Students (2001-02)</strong></td>
<td>3.a, 3.b, 3.c, 3.d, 3.e, 3.f, 3.g, 3.h, 3.i, 3.j, 3.k &amp; 3.e</td>
<td>Professional assessment needs analysis, instructional design, formative assessment, program planning, implementation, feedback analysis, and improvements.</td>
<td>Transfer of best practices, planning program objectives, course materials development, participative instructional design, evaluation of the feedback and improvement</td>
<td>Confidence in professional competencies, leadership development, improvements based on the feedback, communication skills.</td>
</tr>
<tr>
<td><strong>Industry Sponsored Dissertation Works by M.Tech (HRD) Students</strong></td>
<td>3.a, 3.b, 3.c, 3.d, 3.e, 3.f, 3.g, 3.h, 3.i, 3.j &amp; 3.k</td>
<td>Evaluation of the existing methods, planning for innovative methods, testing, development, patenting, publication,</td>
<td>Getting the suggestions, seeking cooperation from the companies, explaining the utility of the advanced methods</td>
<td>Professional leadership, problem-solving, creativity, commitment to excellence, achievement motivation, communication skills, research skills</td>
</tr>
<tr>
<td><strong>Open-ended Students Seminars to Solve Technology</strong></td>
<td>3.a, 3.b, 3.c, 3.d, 3.e, 3.f, 3.g, 3.h, 3.i, 3.j &amp;</td>
<td>Selection of topics, literature survey, problem definition, analysis, proposal for alternative but cost</td>
<td>Relating the general problems of MSMEs to the curriculum, use of emerging technology, and look</td>
<td>Research and development, communication, assessment of needs, inquiry, transfer and</td>
</tr>
</tbody>
</table>
### Problems of MSMEs

<table>
<thead>
<tr>
<th>Industry Specific Case Study Preparation</th>
<th>effective solutions.</th>
<th>for innovation support</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.a), 3.b), 3.c), 3.d), 3.e), 3.f), 3.g), 3.h), 3.i), 3.j) &amp; 3.k).</td>
<td>Evaluation of failures/successes, identification of problems in design, execution, root cause analysis and alternate solution</td>
<td>Collection of field problems, relevance to technology, root cause analysis, generation of solutions and identification of the benefits</td>
</tr>
<tr>
<td>Quality Circle to Improve the Relevance of Product Development</td>
<td>Analysis of problems, brainstorming, getting various solutions, evaluation, and identification of the best solution</td>
<td>Formation of learning group, selection of problems, analysis, rank ordering the solutions and evaluation of implementation problems and identification of the best solution</td>
</tr>
</tbody>
</table>

All these initiatives need the commitment of educational administrators and the motivated faculty. Since many initiatives have been piloted and implemented in selected institutions, it is stated they can be diffused in many other engineering colleges which are strategically planned with excellent faculty and motivated students. The polytechnics achieved maximum placement through campus interviews. The faculty could be trained as a part of skill development. They could prepare case studies, industry-specific projects in consultation with the companies in the industrial corridor and hubs. The demand also increased to train the selected technicians and the engineers from the companies. They representatives of the companies readily participated in all consultative meetings, curriculum evaluation and validation meetings.

### Summary and Conclusions

Research shows that many engineering students need hard skills to meet the requirements of the modern industries. Hence, steps could be taken to modernize the existing graduate and postgraduate programs so that they are competent for design and manufacturing technologies.

In this 21st century, all the advanced nations have invested in soft skills training of their engineering graduates and the industries have received industry ready and creative graduates.

Soft skills are very much required for the early employment of the Indian engineering graduates. To improve the soft skills steps are to be taken to focus on them. There is a need for commitment and strategic planning.

### References


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