6. ENGINEERING DEGREE COURSES - FOCUS ON OUTCOME

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Abstract

Various kinds of industries use engineering to generate and maintain economy in the country by creating goods and services. The responsibility of academia is to provide quality-engineering education, so that the graduates are able to perform as per the requirement of industries. It is assumed by academic world that engineering education system is developing the required abilities in degree pass outs, while the industries have always complaining about the quality of fresh graduates. In USA, researches are being conducted by academia to find out the extent of satisfaction on the abilities being developed in fresh graduates. The regular feedbacks are being sought from the world of employment on extent of development and further requirement of abilities. In our country, these kinds of researches need to be conducted continuously to improve the quality of education.

Introduction

India has a young population to be educated on one side, and on the other side its own national problems of illiteracy, poverty and unemployment. These two issues may be tackled with huge quantity and quality of technical education as well as using engineers to build technologies with application of science. The bulk of technical education is being taken care of by AICTE, who has already approved 2388 engineering colleges as on 31-8-2008 and further proposals of 886 new engineering colleges have been received for 2009-10. The next big question is about quality of pass outs. It is assumed by academic world that engineering education system is developing the required abilities in degree pass outs, while the industries have always complaining about the quality of fresh graduates. The pressure of tough competition from market forces due to liberalisation, economic recession and globalisation has added further fuel to the fire. There is a need to find out the extent of satisfaction on the abilities being developed in fresh graduates from the world of employment as well as requirement of abilities, which are not being addressed to by the academia. A literature review was done to assess the nature and quantum of work done in the area of establishing the various abilities and their state of development in fresh graduates. In determining the contributions, the various internet sites were visited, like- UNESCO International Centre for Engineering Education (UICEE), Global Journal Of Education, Journal of Engineering Education (ASME, USA) as well as current and old copies of the journals, like- the International Journal of Engineering Education as well as Indian journals. Summary of the literature reviewed is -

International Literature Surveys-

Impact of Globalisation

1. Badnan, A. (1997) has described the impact of globalisation on engineering education.

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Universities will have to increasingly compete in two areas- quality of education and the quality of their graduates. In a global market, the competition will be fierce in research and development (R&D). He has also stressed the role of engineering institutes, science and industry for development of new products.

2. Jensen et al. - (1998) have discussed the internationalisation of engineering graduate at Technical University of Denmark (DTU). Graduates from DTU are increasingly employed in jobs in which they are dealing with international partners or joint international research projects etc. DTU has planned for development of ability for its graduates to function in an international setting.

3. Nguyen, Duyen Q. (1998) has carried out a survey of academics, industry personnel and students in Australia with the objective of eliciting their views on the essential generic and specialist skills and attributes for a modern engineer. The research indicates that engineering curricula need to be revised; universities must make provision for updating engineering subjects and learning material, which are capable of enhancing the skills and attributes of future engineers to meet the changing global environment.

4. Smith, Jr. Clifford V. (1999) has expressed his views on the *quality of engineering faculty* that the ideal faculty person is one who combines formal academic training together with practical experience. *Experience as a practising engineer enables faculty members to develop better abilities in students.*

Abilities Assessment-

5. Leinonen et al. (1999) have carried out a survey that shows that the technical skills of mechanical engineers correspond reasonably well to the demanded requirements, but some weaknesses are noted in quality, technology, logistics, development & implementation of data processing systems. The findings also show that the major deficiencies are in non-technical skills- *leadership, knowledge of languages, negotiation skills, project work, interpretative ability, the use of data processing systems, and understanding of the functioning of a company as a whole.*

6. Lang, James D. et al. (1999) have conducted a first formal survey with efforts of the Industry-University-Government Roundtable for Enhancing Engineering Education (IUGREEE) of fifteen aerospace and defence companies concerning ABET Program Outcomes, Criterion 3, that engineering programs should demonstrate the abilities their graduates possess. The survey instrument listed 172 skills, knowledge descriptors and experiences that were mapped into the ABET 2000 Criterion 3 eleven outcome categories. The respondents were asked to rank each in importance for an entry-level engineer on a scale of 1 (very low) to 5 (very high). The survey produced 420 voluntary responses from engineers and engineering managers representing fifteen of the twenty-four aerospace and defence-related companies. The survey results are formatted to show for each survey item: Response count, Average importance ranking, Standard Deviation, Maximum, minimum, and maximum-minus-minimum importance levels & Median and mode importance level. The 172 items, when ranked, give an indication of desirable curriculum objectives. University curriculum designers can sort the data to analyse by engineering experience or job category. Careful attention must be given to understand the data and their limitations. The survey provides an example of what can be obtained from industry in order to better understand their outcomes expectations for entry-level engineers. This survey goes beyond that to include expectations for engineers with 3 to 5 years of experience, and can be used to design continuing education, on-the-job training, or MS level outcome objectives.

7. Heitmann, Guè Nter(2000) has analysed the

engineering education in Germany. Presently Germany is holding provisional status in Washington Accord. Germany is developing those procedures with the goal of achieving signatory status in due course. Accreditation of courses of study will involve- *the extension of the objectives of accreditation procedures to the encouragement of quality improvement, the shift from in-put to outcome assessment, the widening of external assessment procedures granting greater flexibility for the peers to recognize special profiles instead of executing a rigid application of detailed standards; finally, the checking and proof of the existence of an internal quality assurance system as one of the evaluation criteria.*

8. Meier, Ronald L. et al. (2000) have carried out a study to explore the extent of competency gaps in science, mathematics, engineering, and technology (SMET) education graduates as perceived by business and industry leader. The study was to find out non-technical competencies, extent of their performance and gaps between expectations and performance. A total of 54 items being identified as high priority competencies were evaluated for the *importance* and *performance.* A total of 415 completed responses were returned for a response rate of 23 percent. This study found that SMET programs must extend the boundaries of their traditional curricula to include competencies such as: *customer expectations and satisfaction, commitment to doing one's best, listening skills, sharing information and cooperating with co-workers, team working skills, adapting to changing work environments, customer orientation and focus, and ethical decision making and behaviour.*

9. Seat, Elaine et al. (2001) have made a profile of engineering graduate. They have mentioned that recent industry surveys highlight the need for engineering graduates to have more than just technical competency. The Society of Manufacturing Engineers conducted an industry survey to guide their future educational emphasis. *This effort focused on identifying competency gaps in engineering skills. Of the 14 identified competency gaps, seven were associated with performance skills in areas of teamwork, communication, personal attributes of interacting with diverse populations, project management, ergonomics, and business skills.*

10. Swearengen J.C. et al. (2002) have described abilities in five areas for developing global engineers out of degree programme for manufacturing engineering. These abilities were derived by an industry panel to update expectations for manufacturing engineering education under American Society of Mechanical Engineers Congress The speakers represented the Aerospace, Electronics, Automotive and Transportation, and Materials sectors. They have discussed the challenges for the global working of engineers and following mentioned abilities have been prescribed.

A. Liberal arts- Near native proficiency in foreign language including technical vocabulary, More refined levels of communication & interpersonal skills including nonverbal, In-depth cross-cultural competence, Ability to function as members, at large, of a foreign society, Ability to function on cross-cultural, cross-time zone teams.

B. Business- Understanding of global markets, international trade& financial process management, Working knowledge of business management practices, Ethical standards, especially within cultural context.

C. Standards- Understanding of Unified & International standards, Familiarity with local codes & regulations, Professional registration & licensing.

D. Personal Management- Embrace change, Flexibility & adoptability, Ability to work any time/place/location, Accept life long learning as a way of life, Develop & execute a career plan.

E. Holistic engineering practice- Systems thinking , Critical thinking, Learn to do good with engineering, Couple technical innovation to the world market place.

11. Ashraf A. Kassim et al (2002) The National University of Singapore engineering curriculum has been constantly evolving. The graduate engineers should not only possess the traditional attributes of good problem-solving, analytical, interpersonal, communication, management and decision-making skills but also the modern attributes that enable them to practice their profession with competence and confidence in the ever changing world. These modern attributes include *learnability (ability to learn on one's own), a yearning for life-long learning, innovativeness and creativity, ability to muster knowledge from various disciplines, to employ IT, to work at the interfaces between traditional disciplines, to work in a team and to possess an international outlook.*

12. Boeing List of Desired Attributes (2003): Boeing company has developed desired attributes of an engineer as follows-

- A good understanding of engineering science fundamentals- Mathematics, Physical and life sciences, Information Technology.
- A good understanding of design and manufacturing process.
- A multi-disciplinary systems perspective.
- A basic understanding of the context in which engineering is practised- Economics including business practice, History, Environment, Customer and societal needs.
- Good Communication Skills- Written, Oral, Graphic, Listening.
- High ethical standards.
- An ability to think both critically and creatively-independently and co-operatively.
- Curiosity and a desire to learn for life, and
- A profound understanding of the importance of teamwork.

13. Bjorklund Stefani A. et al. (2004) have conducted *a study to examine the relationships between engineering faculty teaching practices, classroom climate and students' perceptions of their gains in certain abilities. These were communication skills, problem solving skills, occupational awareness and engineering competence in subject engineering design of curriculum. Data were gathered from more than 1,500 students taking the first-year design course offered at 19 campuses of the Penn State system over a period of two years.* The results suggest that faculty interacting with and providing constructive feedback to students were significantly and positively related to students' self-reported gains in several design and professional skills.

14. Magee (2004) as part of assessment of new mechanical engineers in Ford Motor Company has developed 11 attributes as abilities of a design mechanical engineer, these are-

- Determine quickly how things work.
- Determine what customers want.
- Create a concept.
- Use abstractions/math models to improve a concept.
- Build or create a prototype version.
- Quantitatively and robustly, test a prototype to improve concept and to predict effectiveness.
- Determine whether customer value and enterprise value are aligned (business sense).
- Communicate all of the above to various audiences.
- Much of this requires domain-specific

knowledge and experience.

- Many require, systems thinking and statistical thinking, and
- All require teamwork, leadership and societal awareness.

15. Lee Downey, Gary et al. (2006) have discussed the competencies of engineers to work globally. A minimum-learning criterion for global competency and three learning outcomes for engineering students have been described. The criterion is *"through course instruction and interactions, students will acquire the knowledge, ability, and predisposition to work effectively with people who define problems differently than they do."* The three learning outcomes are- The student will-

- *demonstrate substantial knowledge of similarities and differences among engineers and non-engineers among the world.*
- *demonstrate an ability to analyse how people's lives and experiences in other countries, may shape and effect what they consider to be at stake in engineering work.*
- *display a predisposition to treat co-workers from other countries, as people who have both knowledge and value, may like to hold different perspectives to bear in process of problem definition and problem solution.*

16. Richard, Goering (2007) in his article "Engineering education prepares for 2020" has mentioned an engineer's knowledge used to be obsolete at half of its life, now it may be as little as five years. She also pointed towards the expectations of the industry from the engineering education. He has mentioned that industry will require a variety of skills not commonly taught in universities today. *There will be need to teach attributes like creativity, flexibility, leadership, business acumen, analytical skills, ethical standards, ingenuity, leadership, dynamism, agility, and resilience. These will demand an "experiential" approach to education.*

17. Dr. Timoney, David, (2007), UCD Undergraduate Open Days 2007, he has mentioned about the abilities & attributes of Graduate Engineers. These are technical Knowledge & ability to apply theory in practice- *A sound knowledge of disciplinary fundamentals, A strong grasp of mathematics, Creativity and innovation, Work effectively in a business environment, Communication skills, Team working skills, Business awareness of the implications of engineering decisions and investments.*

18. Pomales-García, Cristina et al. (2007) have conducted a study to understand the views and perceptions of engineering undergraduate students on engineering education. Forty-seven undergraduate engineering students participated voluntarily in this study to answer four individual questions and ten group questions. On the question of the types of skills and attitudes that need to be learned, the participants reported that *problem solving, critical thinking, teamwork, communication, interpersonal relations and people skills, creativity, discipline, responsibility, prioritising, time management skills, writing skills, and applying technical knowledge and ethics.*

19. Lamancusa, John S. et al. (2008) the concept of learning factory involves *multidisciplinary student teams develop engineering leadership skills by working with industry to solve real-world problems.* The Learning Factory was founded on three beliefs: lecturing alone is not sufficient; students benefit from interactive hands-on experiences; and experiential, team-based learning involving student, faculty and industrial participation, enriches the educational process and provides tangible benefits to all. Guest lectures by practicing engineers in their field of expertise, add excitement and reality to the classroom. Project sponsors provide urgency and invaluable mentoring to students and faculty in the technical and non-technical aspects of real-world projects. This concept helps to

develop industry-required abilities.

20. Redish, et al. (2008) in their article "Looking Beyond Content: Skill Development for Engineers" have mentioned *the students should also develop the skills to apply this knowledge in real-world situations. Some more abilities need to be developed, such as creativity, teamwork and design, communication, management, economics and ethics. Rapid pace of change of technology requires the engineers to be lifelong learners and learn to develop themselves.*

B. Accreditation Agencies-

21. Engineering Professors Council (2000), London has formulated an Engineering graduates out put standard, in which seven generic abilities have been identified for all the disciplines of the engineering based on the information about their industries. These abilities are-*to exercise Key Skills for Engineering in Communication, IT, Application of Number, Working with Others, Problem Solving, Improving own Learning and Performance. Ability to transform existing systems into Conceptual Models, transform Conceptual Models into Determinable Models, to use Determinable Models to obtain system Specifications in terms of parametric values, to select optimum Specifications and create Physical Models, apply the results from Physical Models to create Real Target Systems, to critically review Real Target Systems and personal performance.*

22. Accreditation Board for Engineering and Technology -ABET (2000) is recognized in the United States as the sole agency responsible for accreditation of educational programs leading to degrees in engineering. Criteria 3 have clearly stated that any engineering programme should have the eleven graduate abilities as outcome and the same should be tested during the course of engineering education. These are- *ability to apply knowledge of mathematics, science, and engineering; to design and conduct experiments, as well as to analyze and interpret data; to design a system, component, or process to meet desired needs; to function on multi-disciplinary teams; to identify, formulate, and solve engineering problems; An understanding of professional and ethical responsibility; An ability to communicate effectively; The broad education necessary to understand the impact of engineering solutions in a global/ societal context; A recognition of the need for and an ability to engage in life-long learning; A knowledge of contemporary issues; and An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.*

23. Japan Board of accreditation for Engineering Education (2002) have clearly laid down the criteria for accreditation of engineering courses on the basis of certain knowledge and abilities. For mechanical engineering graduates, they have identified eight abilities under criteria 1.These are-*The ability and intellectual foundation for considering issues from a global and multilateral viewpoint, understanding of the effects and impact of technology on society and nature, and social responsibilities of engineers (engineering ethics), Knowledge of mathematics, natural sciences and information technology, and the ability to apply such knowledge, Specialized engineering knowledge in each applicable field, and the ability to apply such knowledge to provide solutions to actual problems, Design abilities to organize comprehensive solutions to societal needs by exploiting various disciplines of science, as well as various types of technology and information, Japanese-language communications skills including methodical writing, verbal presentation and debate abilities, as well as basic skills for international communications, The ability to carry on learning on an independent and sustainable basis, The ability to implement and*

organize works systematically under given constraint.

24. National Board of Accreditation, India- has recently laid down in May'2011 ten criteria for evaluating any engineering program in a college.

i. Criterion I deals with Organization and Governance, Resources, Institutional Support, Development and Planning- Campus infrastructure and facility, Organization, governance and transparency, Budget allocation and utilization, Library, academic support units & common facilities, internet, co-curricular & extracurricular activities, Career guidance, Training, placement and Entrepreneurship cell, Safety norms and Checks, Emergency medical care and first-aid (Max marks=100, Min. Qualifying Points -60)

ii. Criterion II deals with Academic Processes, Academic Support Inits and Common Facilities, Tutorial Classes/ Remedial Classes/ Mentoring, Teaching evaluation process: Feedback system, Self Learning and Learning beyond syllabus, Career Guidance, Training, Placement and Entrepreneurship Cell, and Co-curricular and Extra-curricular Activities (Max marks=100, Minimum Qualifying Points – 60).

iii. Criterion III deals with Students' Entry and First Year's Performance - Students admission, Student –Teacher Ratio for First Year, Faculty QWualification for First Year, and Academic Performance in First Year Common Courses, (Max marks= 75 Minimum Qualifying Points=45) [Based on past 3 years record]

iv. Criterion IV deals with Student Performance in the Programme- Success rate, Academic Performannce, Placement and Higher Studies and Professional Activities Max marks= 75 Minimum Qualifying Points =45) [Based on past 3 years record]

v. Criterion V deals with Faculty – It includes Student Teacher Ratio, Faculty Cadre Ratio, Faculty Qualification, Faculty Retention, Faculty Research Publications, Faculty IPR, Faculty R&D and Consultancy work and Faculty Interactions with Outside (Max marks=150,Minimum Qualifying Points – 90 [Based on past 3 years of the records]

vi. Criterion VI deals with Facilities and Technical Support - Class rooms, Faculty rooms, Laboratories including computing facility, Technical manpower support (Max marks= 75, Minimum Qualifying Points 45)

vii. Criterion VII deals with Continuous Improvements- Improvement in Success Index of students, Improvement in academic performance of students, Improvement in Student Teacher ratio, Enhancement of faculty qualifications, Improvement in Faculty activities in research publication, R & D work and consultancy, Continuing education, New facility created, Overall improvements since last accreditation, if any, otherwise, since establishment (Max marks= 75, Minimum Qualifying Points –45) [Based on past 3 years of the records].

viii. Criterion VIII. deals with Curriculum- Contents of basic sciences, HSS, professional core and electives, and breadth, Emphasis on laboratory and project work, Additional contents to bridge curriculum gaps (Max marks= 100, Minimum Qualifying Marks 45).

ix. Criterion IX deals with Program Educational Objectives – PEOs mapping with curriculum, PEOs mapping with Content delivery- theory and labs, PEOs mapping with evaluation, PEOs mapping with final year project work and Continuous improvement improvement in the process of PEOs mapping and (Max marks= 150 Minimum Qualifying Marks 90).

x. Criterion X deals with Programmes Outcomes and Assessment- It deals with demonstration of attainment of mandatory a-k outcomes, Assessment of outcomes by external stakeholders, and Effectiveness and efficiency mechanism / procedure for continuous review and outcome measurements (Max marks= 100 Minimum Qualifying Marks 60).

General Report about the strengths, weaknesses and deficiencies, if any. Regarding outcome, the engineering programmes must demonstrate their graduates have following capabilities: knowledge of mathematics, science and engineering, to identify, formulate and solve engineering problems, to design and conduct experiments, analyze and interpret data, to design a system, component or process as per needs and specifications, to visualize and work on laboratory and multidisciplinary tasks, to use modern engineering tools, software and equipment to analyze problems, knowledge of professional and ethical responsibilities, to communicate effectively in both verbal and written form, show the understanding of impact of engineering solutions on the society and also will be aware of contemporary issues, develop confidence for self education and ability for life-long learning, participate and succeed in competitive examinations.

Most of these criteria (i) to (viii) are assessing inputs and state of affairs of teaching learning processes, there is only one criteria-(ix) of marks 150 out of 1000 to focus on students' outcome in the form of abilities, like criteria 3 of ABET, USA, which is slightly sufficient. The passing marks are 750 for 5 year accreditation, now institute may have difficulty to get accreditation without achieving this criterion.

C- Based on Accreditation Policies-

24. Koehn, Enno "Ed", (2001) has assessed the development of abilities as per ABET 2000 criteria along with engineering program for civil engineering course in Civil Engineering Department of Lamar University. A survey instrument was distributed to undergraduates, graduate students, and practitioners with response rate of roughly 80%, 90%, and 60% respectively. *The result was that more stress on abilities in four-subject areas-Mathematics, Structural Engineering, Geo-technical Engineering and Major design. A lower stress was recommended for-procurement of work, bidding versus quality-based selection, interaction of design and construction professionals, and importance of continuing education.*

25. Prados, John W. et al. (2005) have tried to find the impact of ABET Engineering Criteria 2000 through a study to answer the question "Are engineers who graduated from programs since implementation of the EC2000 standards better prepared for careers in engineering than their counterparts who graduated before introduction of the criteria?" The study targets programs in seven engineering disciplines. The study found the survey reported that attention to each of the seventeen curricular topics associated with the eleven student learning outcomes had increased in the past ten years. To enhance the future impact and effectiveness of accreditation, several research questions need to be addressed: *What does the engineering profession believe are the significant intellectual skills, knowledge, and capabilities of engineering graduates required to satisfy the future needs of the profession?*

26. Jarosz, Jeffrey P. et al. (2006) have carried out the study of curricula of eight engineering colleges for Mechanical Engineering course, as the *current curricular structure tends to differ academic fundamentals from applications and students are not being exposed engineering as it is practiced.* These factors prompt a high attrition rate from engineering. They have found that that although ABET engineering outcomes are closely linked to the mechanical engineering curricula across the nation, the match is not perfect. ABET engineering criteria for development of abilities are viewed seriously in technical area, but in the professional area

least clearly addressed, such as- *teamwork, ethics, communication, the impact of engineering on society, and knowledge of contemporary issues.*

D. Indian Literature survey-

27. Rajeswari R. (1994) has stressed the need to make in depth study of impact of technical manpower on the industrial sector. According to her, study should include *employment characteristics, technology status of the industry, and the skill requirement of industry.*

28. Palit, Sajal K. (1998) has compared two engineering colleges of the country; IIT, Delhi and BITS, Pilani for describing on several important academic aspects, *The author has concluded that institutions should adopt more job and object-oriented engineering education curricula linked with industries and research organisations* to meet the present and future challenges of rapid technological changes and industrial development in India.

29. World bank report (2000) on "Scientific and Technical Manpower Development in India" has raised concern on poor quality and relevance in most institutions, which offer outdated programs with inflexible structures and content. There is a mismatch between student demand/labor market needs and institutional output and training modalities.

30. Natarajan, R. (2000), has raised various issues of quality in technical education, specially the engineering education. According to him, US National Science Foundation (NSF) task force on TQM has defined quality to develop intellectual skills and knowledge that will equip graduates to contribute to society. Development of abilities of graduates is a prime concern in quality. He has further stressed, along with technical performance ability, certain other abilities for 21st century of graduates as- *ability to communicate, think creatively, learn quickly, value diversity, muster knowledge from neighbouring disciplines, work in a team, employ IT and work at interfaces between traditional disciplines.*

31. Joshua (2004) has prepared a list of 44 abilities as part of competency based abilities bank for the electrical engineering degree pass outs. Out of 44 abilities, 14 abilities are in generic areas and 30 abilities are in technical areas.

32. Ravindra M. P.(2007) The expectation of an IT company- Infosys from the fresh engineers are that they should possess the six abilities or skills- *Algorithmic thinking and problem solving, demonstrate flexibility, Mathematical Modelling for optimal architecture and design, Performance modelling and optimisation, Developing an innovative mind set, Capability to propose and sell through a solution, Demonstrate continuous learning and excellent 'learnability.'*

33. FICCI & NMIMS (2007) have reported that India produces about 350,000 engineers annually to our workforce, yet at any given time large numbers of graduates are unemployed. A survey done by McKinsey Global Institute shows multinationals find only 25 percent of Indian engineers employable and a NASSCOM report foresees shortage of 500,000 knowledge workers by 2010. There is also a need to understand industry/ employer changing needs, variable sector specific skills and training requirements to improve performance. *Education providers should continuously identify common skills or abilities and as well as sector specific knowledge and skill needs.* The present generation of engineers is also challenged to find solutions to population, energy, environment, food, water, terrorism, housing, health and transportation problems.

34. Banerjee, Rangan et al (2007) have analysed the situation of engineering education in India. They have mentioned that engineering colleges should produce engineering graduates, post graduates and doctorates with such a capability that they evolve new

technologies for the society for sustainable development. The engineering colleges should collaborate with industries in manpower planning, training and producing able graduates and postgraduates for their research, development and design works. Industry should also define key research areas and potential research problems to sponsor such activities.

Conclusions:

In USA, ABET is managing the accreditation system for the engineering colleges, which is based on input resources and outcomes of students' in the form of abilities that are being developed during academic experiences. A number of studies were found, which were directed to find the kind and extent of knowledge, attitudes and skills required by various industries, as well as to what extent these are available in fresh graduates. Such studies are- Leinonen et al.(1999), Lang James D. et al.(1999), Seat, Elaine et al.(2001), Swearengen J.C. et al.(2002), Gary et al.(2006), Jarosz Jeffrey P. et al.(2006), Richard Goering (2007), Lee Downey Pomales-García, Cristina et al.(2007), Redish et al.(2008), etc. The accreditation system of England and Japan also focuses on outcome of students.

In India, various concerns have been raised about the requirements of industries from the academic world, like- Rajeswari R.(1994), Palit, Sajal K.(1998), Natarajan, R.(2000), Banerjee, Rangan et al(2007), Chugh C.K. (2007), etc. World Bank and FICCI & NMIMS (2007) have also criticised education system. **As has been done in USA, there are no researches to support the kind and extent of knowledge, attitudes and skills required by various industries, as well as to what extent these are available in fresh graduates of engineering. It is high time that such studies are conducted, which will be helpful for the academia as well as industry to improve quality of their outputs.** NBA, India has developed its procedures/ accreditation criteria to meet the needs of Washington Accord for international equivalence of accredited engineering degree courses. New procedures of accreditation of NBA focuses slightly more on outcome based education. There is a need to converge more on development of abilities of students, i.e. their outcome. **We should think beyond Washington Accord and concentrate more on students' outcome.**[36]

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