

## **Shifting Paradigms in Global Engineering Education: the India's Perspective**

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### **ABSTRACT**

**We shape our Education and in turn Education shapes us.** Education, in simple parlance, means to impart knowledge and make it available to others. To some extent; the task, challenges and opportunities for education in all the sciences and professions are universal in nature. Engineering Education is somehow different all over the world. It faces the biggest challenges on every front. In 21<sup>st</sup> century, engineers are constantly bombarded with the new technologies. For sure, it puts tremendous pressures on our professional & scientific institutions including universities and poses a big responsibility on them. Engineering Education plays a vital role in human resource development of the country by creating skilled manpower, gainful employment, enhancing industrial productivity and improving the quality of life of its people in total. To achieve all these objectives, we need to embark on the means, capability and competence of Engineers on par footing basis, as never than before. The Engineers must have solid scientific background with multi-skills in interdisciplinary areas. They should be capable of adopting innovations with fast changing economic and social factors and ready to work in a team spirit with yearning for life-long learning which in turn, giving them access to productive, profitable and rewarding employment in future.

In India, the existing system is a mix of what was designed and what has evolved, both of which need a critical appraisal and review. To achieve the esteemed goal of producing well qualified, trained global technocrats with their culture and values intact; India urgently needs a coordinated blueprint for technical education, research and development encompassing Governments, private sectors, and research and academic institutions, consistent with the industrial, technological and economic future of the country.

**Keywords: Global Engineering Education, Washington Accord, Outcome Based Education, NBA Accreditation, India**

## INTRODUCTION

*VIDYAYĀ AMṛTAM AŚNUTE /*

*(EAT NECTAR THROUGH*

*KNOWLEDGE / BE IMMORTAL THROUGH KNOWLEDGE)*

Throughout history, there have been many notable engineers and inventors who have changed the way we live through their creations and innovations. Engineering stimulates the mind. Travelling to moon was one of the most beautiful dreams of the mankind; Engineers turned the dream into reality. Engineering is everywhere – be it in mobile phones, in skyscraper building, in dish washing machines, in softwares, in satellites or in robotics. Architects and engineers are among the most fortunate of men since they build their own monuments with public consent, public approval and often public money. With the exponential growth of engineering around the globe, the world faces tremendous pressure to achieve the sustainable development goals. Through interdisciplinary areas, our global society has never needed engineering more and also we have never been in a better position to respond.

Since the theme of the conference is “*Achieving and Sustaining Excellence in Quality, Reliability, Service and Operations*”, one expects bold aspirations and actions in the service of humankind. Engineering problems need to be redefined. There are many good or bad solutions for that. The art lies in arriving at a good solution. This is a creative activity, involving imagination, intuition and deliberate choice. In the role of as an engineer, our Mission is to serve as the global network of engineers and mobilizing them to advance engineering education, research, and services to the global community. To achieve these objectives, we must focus on institutional leadership formation, curriculum leadership, corporate and public engagement and accreditation leadership.

## THE WASHINGTON ACCORD

Globally, there are at least half a dozen accords on engineering education and all of them are non-governmental, with Washington Accord being the most popular one. The Washington Accord is an international accreditation agreement for professional engineering academic degrees, between the bodies responsible for accreditation in its signatory countries. Established

in 1989, the signatories as of 2014 are Australia, Canada, Taiwan, Hong Kong, India, Ireland, Japan, Korea, Malaysia, New Zealand, Russia, Singapore, South Africa, Sri Lanka, Turkey, the United Kingdom and the United States[1]. The agreement recognizes that there is substantial equivalence of programs accredited by those signatories. Graduates of accredited programs in any of the signatory countries are recognized by the other signatory countries as having met the academic requirements for entry to the practice of engineering. Recognition of accredited programs is not retroactive but takes effect only from the date of admission of the country to signatory status.

Engineering technology and postgraduate programs are not covered by the accord, although some engineering technology programs are covered under the Sydney Accord and the Dublin Accord. Only qualifications awarded after the signatory country or region became part of the Washington Accord are recognized. The accord is not directly responsible for the licensing of Professional Engineers and the registration of Chartered Engineers, but it does cover the academic requirements that are part of the licensing processes in signatory countries. The following are the signatory accreditation bodies of the Washington Accord, their respective countries and territories, and years of admission:

1. Australia - (Engineers Australia, 1989)
2. Canada - (Engineers Canada, 1989)
3. Chinese Taipei - (Institute of Engineering Education Taiwan, 2007)
4. Hong Kong, China - (The Hong Kong Institution of Engineers, 1995)
5. India - (National Board of Accreditation, 2014)
6. Ireland - (Engineers Ireland, 1989)
7. Japan - (Japan Accreditation Board for Engineering Education, 2005)
8. Korea - (Accreditation Board for Engineering Education of Korea, 2007)
9. Malaysia - (Board of Engineers Malaysia, 2009)
10. New Zealand - (Institution of Professional Engineers New Zealand, 1989)
11. Russia - (Association for Engineering Education of Russia, 2012)
12. Singapore - (Institution of Engineers Singapore, 2006)
13. South Africa - (Engineering Council of South Africa, 1999)
14. Sri Lanka - (Institution of Engineers, Sri Lanka, 2014)

15. Turkey - (MÜDEK, 2011)
16. United Kingdom - (Engineering Council UK, 1989)
17. United States - (ABET, 1989)

The following countries have provisional signatory status and may become member signatories in the future:

1. Bangladesh - (Board of Accreditation for Engineering and Technical Education)
2. People's Republic of China - (China Association for Science and Technology)
3. Costa Rica - (Association of Engineers and Architects of Costa Rica)
4. Mexico - (Consejo de Acreditación de la Enseñanza de la Ingeniería)
5. Pakistan - (Pakistan Engineering Council)
6. Peru - (ICACIT)
7. Philippines - (Philippine Technological Council)

## **THE WASHINGTON ACCORD & OUTCOME BASED EDUCATION (OBE)**

The Washington Accord covers undergraduate engineering degrees under Outcome-based education (OBE) approach [2]. It concerns that the traditional education system may not adequately prepare students for life and work have prompted a thorough review of education. It has been found that Graduates are not completely prepared for the workforce due to lack of emphasis on soft skills needed in jobs e.g. communication skills, office skills, human relationships skills etc. OBE's instructional planning process is a reverse of traditional education system. In this, students are expected to be able to do more challenging tasks other than memorize and reproduce what was taught. Students should be able to: write project proposals, complete projects, analyze case studies, give case presentations, show their abilities to think, question, research, and make decisions based on the findings. The desired outcome is selected first and the curriculum, instructional materials and assessments are created to support the intended outcome. All educational decisions are made based on how best to facilitate the desired outcomes. OBE is basically implemented to ensure that our academic programmes, delivery system, assessment methods and our graduates are of high quality. Students are also expected to be creative, able to analyze and synthesize information, able to plan and organize

tasks, able to work in a team as a community or in entrepreneurial service teams to propose solutions to problems and market their solutions Assessments in OBE The learning outcomes are set out sequentially on a gradation of increasing complexity that students are expected to master. It focuses on how much and how well the students have learnt. Weaker students may have to follow a different learning path & finish later [4].

## **WA BOOST & NBA RESPONSIBILITIES AHEAD**

After years of effort and several failures, India finally became the 17th member of the exclusive Washington Accord in 2014. Membership means global recognition of Indian degrees and is likely to increase the mobility of engineers to the USA and other countries for jobs. It will help in creating equivalence of engineering degree programmes and allow Indians to practice engineering in other member countries (Washington Accord will, however, not be valid for IT engineers and for this India has to sign the Seoul Accord.). The Seoul Accord, which commenced in 2008, exclusively focuses on computing and software engineering programmes. Isn't it intriguing that India is not a part of this accord? India should have been chairing the accord considering that we boast more than a 3.1 million-strong IT workforce and our engineering education system are already tilted towards the IT industry.

However the WA agreement recognizes that the undergrad engineering programs accredited by these signatories are equal in nature and that the graduates of signatory countries are recognized by other signatory countries as having met the academic requirements for entry to practice of engineering. This development will ensure that highest quality assurance standards (are) implemented in our technical and engineering programmes to provide global mobility to our engineering graduates. As it is an international accreditation agreement for professional engineering academic degrees, between the bodies responsible for accreditation in its signatory countries. In India the body responsible for accrediting the engineering degrees is the National Board of Accreditation (NBA) [6].

Becoming part of Washington Accord also does not necessarily mean that all engineering degrees by all Indian colleges will get equivalence with those of other member countries. NBA

has shortlisted 220-odd engineering colleges as Tier-I institutes whose undergraduate engineering programme is in tune with what is required under the Accord. But even Tier-I institutes which include IITs/NITs/BITS Pilani besides many autonomous and deemed universities will now have to apply afresh to NBA and only after extensive verification of their programmes will they be declared fit to be part of Washington Accord institutions. A massive redesigning of course will take place with emphasis on outcomes and letting students explore and innovate.

For the crowded list of Tier-II institutions, NBA has given a roadmap so that they are well prepared to become members of Washington Accord. NBA has asked universities to allow affiliated engineering colleges to design at least 50% of the course. For instance, Washington Accord lays emphasis on teaching social sciences along with engineering. As Engineers should have knowledge of the environment so that they know how their work is going to have an impact on the ecosystem. They also need understanding of society, management and communication skills [5].

### **IS INDIA READY FOR IT?**

In India, Institutions like the IITs, NITs and a few other public and private technical universities are admittedly performing well. The problem is that these institutions produce less than 5-10 per cent of the engineers in India. Most other institutions are in serious need of improvement in their quality. A majority of these are affiliated to universities and teach the curriculum developed by the affiliating university. As a result, they lack the incentive to continuously improve the quality of teaching and learning and are not geared to adapt to the changing qualification needs of the job market. These colleges mostly focus on undergraduate teaching and their post-graduate programs are often weak. Furthermore, they lack a systematic capacity building effort in education and research. The quality assurance and accreditation efforts of these institutions can be characterized by “compliance” rather than “improvement” tool. Most of them do not have a deep engagement with the employers and are rarely involved in regional development and partnerships with local economic players. Without strong links in the industry, the colleges have

a deficit of entrepreneurial and innovation spirit. And hence, the students and the faculty get little exposure and have little to no experience when it comes to solving practical problems [7].

## **TRANSFORMING ENGINEERING EDUCATION FOR A BETTER GLOBAL WORLD**

To address the challenges faced by the Indian Institutions, University, Industry and Business markets and to find out the superior viable solutions, a top level Workshop on "Implementing Strategies for Engineering Education in India Towards 2025" (EEI 2025) was organized on January 9, 2015 by All India Council for Technical Education (AICTE), the Confederation of Indian Industries (CII) and the World Bank in collaboration with Infosys, the Global Engineering Dean's Council (GEDC) and the Indo-US Collaboration for Engineering Education (IUCEE) at the Infosys Campus, in Bangalore.

At the end of the workshop, they came up with certain recommendations for engineering institutions which needs a complete overhaul of the present system in becoming high-performing engineering institutions, over the next ten years. According to experts, excellent teaching and research-intensive institutions are needed with full academic autonomy and adequate financial autonomy. Each engineering institution should develop visions and institutional norms, to encourage innovation and entrepreneurship, by targeting specific research goals seeking quantifiable goals, giving the students opportunities to be part of research projects with industry and inserting development of entrepreneur skills in the curriculum. The journey of commercialization is still new for most engineering institutes in India including many of the IITs. Academicians do not have the expert knowledge in business development. Institutes should thus be encouraged to set up business development centers staffed with professionals with business, marketing and IPR expertise.

Adaptation of academic framework needs to be responsive to stakeholders (Institutional leaders, Faculty & students, Industry partners and Alumni) needs. Besides student's learning should be based more on experiential/practice based curriculum and in tune with employers' expectations. It is essential to establish a close cooperation between faculties of engineering and industry in order that they may both participate in the engineering education and training. Furthermore, a

common space must be developed for interactions where students, faculty and business people can develop ideas from the invention stage to a successful innovation, where the invention has been successfully commercialized.

While designing, developing and delivering the new courses, curriculum or programs, strong link and association with industry is very much needed especially in CSE/IT discipline. Educational systems should offer courses based on e-learning models using web based tools also. These courses should be offered to the practicing Engineers and should be “on a need basis” taking into consideration the Engineer’s specific needs for new knowledge and skills. Effective ICT (Information & Communication Technologies) adaptation to enhance student learning and faculty competence is very much needed so that Faculty training can be strongly linked to institutional processes and aspirations.

Besides, Strong Post-Graduate and Research Programs, Centers of Excellences (led by strong academic leaders and administrators who continually drive institutional aspirations) should be in priority areas for the college. Employer’s satisfaction with quality of the talent pool and Enhanced capability for industry consultancy and IPR (Intellectual Property Rights) generation are going to contribute to the global socio-economic development through entrepreneurship and innovation activities.

## **CONCLUSION**

Conclusively; on the basis of the roadmap, we develop a reasonably good understanding of what needs to be done in order to radically improve the control of governance. However, the main obstruction is the lack of ability to implement these suggested reforms. A national concerted initiative by the Government of India should be launched with input, participation and commitment from all the stakeholders on improving the quality and relevance of engineering education to realize the ‘*Make in India*’ initiative. For the Engineering Institutions in India, our National Agenda / Focus Areas for engineering education should be “*Quality of Teaching and Learning*”, “*Industry-Institute Partnership*”, “*Innovation and Entrepreneurship*” through better and transparent “*Governance and Leadership*”. This means to inspire both *bottom-up*

*initiatives* that can be taken by leadership of the institutions, faculty and students as well as by industry partners and alumni collaborating with the engineering institutions and *top-down initiatives* that can be taken from central and state governments, regulators (e.g. AICTE) and business associations (e.g. CII, NASSCOM and FICCI). Both *bottom-up* and *top-down* initiatives are necessary to transform engineering institutions. Moreover, many *bottom-up* initiatives can be taken without waiting for central decisions or assistance with close cooperation with Industry.

Moreover, the concerted efforts should systematically monitor, refine and evaluate the progress made on priority basis. The national agenda should furthermore be guided by best practices from around the world as well as from within India, including TEQIP, NPTEL, QEEE and others. These could be adapted with assistance of government agencies (including MHRD, AICTE, NBA, and ISTE) as well as corporate groups. This is by no means an easy task and it will take a long-term effort to build a strong regional, national and international innovation system that promotes industry competitiveness through research collaboration and entrepreneurship, for a better, beautiful and peaceful world.

## REFERENCES

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