Making Indian Engineering World Class

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Abstract— “World-class” engineers denotes the engineers of tomorrow who will be competent enough to turn ideas into reality through the knowledge gained by them. Engineers play an major role in the material progress of the world. A world-class engineer, gains knowledge of the potential value of science and translates it into tools and resources which will help the society as well as the country to develop. To produce large numbers of competent engineering and technical personnel to take on the global challenges, India will need to complete some activities to transform the curriculum for training and skill upgradation like generating awareness about the global nature of the profession in-tune with growing challenges and opportunities and developing a comprehensive understanding in the respective engineering discipline to tackle complex and real-world problems.

Keywords— World class, institution, India, quality, faculty, academics, research, publication, industry.

I. INTRODUCTION

Three decades ago, developed countries such as the US and Japan produced the majority of the world’s engineers. Today, however, a high fraction of the world’s new engineering graduates come from the four largest emerging economies: Brazil, Russia, India and China (National Science Board, 2010), collectively known as the BRIC countries1. The word “world-class” is a relative term and is very difficult to define as there is no datum or fixed standard to classify any engineering work as “world-class”. The phrase has different connotations in countries from different categories, such as developed, developing and under-developed, based on their economic and social standards. India requires large numbers of qualified and competent engineers to address the numerous challenges faced in the developmental journey.

II. ABOUT THE INDIAN ENGINEERING EDUCATION SYSTEM

The higher education system in India is one of the largest in the world2. Although engineering education received much attention in India ever since independence, it is only during last decades, engineering education has expanded remarkably as indicated by rapidly increasing number of engineering institutions, massive increase in the students admissions and increase in number of engineering disciplines. The discipline wise sanctioned intake in engineering education and the types of engineering institutes in India is shown in the figure 1 and figure 2 respectively3.

III. REQUIREMENTS OF A WORLD CLASS INSTITUTION

The first basic requirement of a world class institution is freedom of action and choice. In institutions like Cornell, Standford, Cambridge etc the leaders of the institutions are the ultimate decision makers on what needs to be done to further the cause of the institution where as in India we lack in taking our own decisions4. Leadership, mindset, meritocracy and humility are some of the critical requirements of a world class institution.

A. Leadership

First and foremost, we need good quality leadership. Leadership is about raising the aspirations of the people. Aspirations build civilization and lead to economic and societal progress. The leader also has the responsibility of translating the vision into a very clear set of action items which could be executed over a specified period.
B. Mindset

It is important to be open-minded and create an environment where we are willing to listen to people who are better than us, have more experience than us, people from other cultures and the people who have treaded the path of progress before us.

C. Meritocracy

We need to create and respect meritocracy. Unless we embrace meritocracy and have the freedom to give opportunity to the best and the brightest we will not make significant progress. We need to benchmark ourselves with the best in the world in each of the dimensions of progress and learn from those practices and improve.

D. Humility

We need a sense of humility. Unless we practice humility, we cannot aspire for higher things. We have to embrace humility if we want progress.

IV. QUALITY IN ENGINEERING EDUCATION

The rapid expansion of engineering institutions has led to a steep deterioration in the quality of education due to acute shortage of numbers and qualification of the faculty, poor laboratory and library facilities and other infrastructure as well as limited or absence of autonomy. Quality in education is a complex concept with varying conceptualizations but at the same time it can be defined with parameters such as excellence in education, value addition in education etc. Quality Engineering Education is the development of intellectual skills and knowledge that will equip graduates to contribute to society through productive and satisfying engineering careers as innovators, decision makers and leaders in the global economy of the twenty first century. It demands a process of continuous improvement and dramatic innovation in student, employer and societal satisfaction by systematically and collectively evaluating and refining the system, practices and culture of engineering education institutions. Number of students completing the degree, time taken to complete the course, passing percentage of students with higher class, number of students recruited by the reputed companies etc. are some of the indicators of student quality.

V. CHALLENGES FACING THE INDIAN ENGINEERING EDUCATION

There are several challenges facing the Indian engineering education system.

A. Number of engineering institutions in India

There is a large number of engineering institutions in India. The exponential expansion in the engineering education system has arisen mainly because of an increase in the number of institutions and the result has been a low number of student and faculty per institution. The current estimated faculty-student ratio of 1 to 24 should be improved to approach the AICTE norm which is 1 to 15 among undergraduates and 1 to 12 among post graduates.

B. Access to engineering education

The access to engineering education remains an issue. The number of students is not sufficiently large relative to the size of the population. Studies find that there are approximately 1,510,000 students enrolled in engineering schools including undergraduates and postgraduates which is quite high, though the number is less than the number in China and Russia. However, relative to the size of the population, the proportion of engineering students is lowest in India (1,290 students per million population). Indeed, the demand for quality engineers is quite significant in infrastructure development and in industry, especially in the emerging field of information technology.

C. Faculty

There is a substantial shortage of qualified faculty. The percentage of faculty with PhDs is low in India. Even in top institutions in an advanced state such as Andhra Pradesh, only 22 percent of faculty members hold PhDs. This is so because only few engineering students are pursuing PhDs. Only 1 percent of all engineering students are enrolled in PhD programs. If India aims to become more competitive in research outcomes, the number of PhD students and faculty with PhDs needs to be raised. The highest qualified as well as talented faculty must be selected in order in increase the quality of education. The same rigour should be ruthlessly applied for promotion, so that only the most talented and accomplished faculties are retained.

D. Research activity

The quality and number of research activities should be given more importance. Research and commercialization outputs have been enhanced. Between 2000 and 2012, the number of publications on engineering matters rose by more than twofold, approaching the number in the United Kingdom (7,500 and 8,900 in 2012 respectively). The research activities have increased in India, but there is room for more improvement.

E. Publications and Patents

One measure of the vibrancy and sophistication of technical activity in a country are publications and patents. It is a sad commentary that India’s share of the world publications in science and technology is 2.5% compared to 9.4% for China and 26.5% for the US. India’s contribution to high-impact research papers is less than 1%. Eighty per cent of the publications from India come out of less than 10% of institutions, suggesting that the bulk of the system is not very productive. In computer science and engineering, a field in which the country is expected to be an emerging leader, only 3.5% of global research output was from India.

F. Resources and Recognition

The major challenge that any institution faces is regarding infrastructure and finance. Particularly for engineering institutions, infrastructure is the fine line that distinguishes one institution from the other and finance is essential for...
setting up world class infrastructure. Apart from finance and infrastructure, recognition from local, national and international policy makers is extremely important as it brings confidence and encourages institutions to be proactive. For a private education provider, therefore, total recognition is a must.

VI. HOW TO JUDGE ANY INSTITUTION

How do we know we are world class? Harvard, Stanford, MIT, etc., are all considered as world class institutions mainly based on rankings given by various magazines as well as their faculty’s publications in peer-reviewed journals. These institutions also give a lot of emphasis on dissemination of the findings. In fact, they have centres of excellence which promote inter-disciplinary research and a lot of interaction with the industry.

Some key initiatives by these institutions include hiring research professors with tenure on a contract basis, supporting presentations by faculty at conferences and giving awards to faculty, reducing the teaching load on the younger faculty for pursuing research, conducting curriculum review on a periodic basis feedback from students and alumni, performance review of faculty for annual increments and rigorous tenure process fund-raising, image-building, branding and business development. The top institutes in our country have lot of opportunities to move up the ladder of excellence. For the existing institutions aspiring to be world class, there is a need to encourage their faculty to publish in internationally refereed journals. This is the dimension in which all the institutions are lacking. It is not that the faculty in these institutions are not doing research but it is just that their research is not published in internationally refereed journals.

VII. IMPROVING THE QUALITY AND MAKING WORLD CLASS ENGINEERING

The biggest failure of the Indian higher technical education system is that none of the IITs and other good institutions finds a place among the top 300 educational institutions in the world and the only institute from India to be listed was IISc at 301–400. Table 1 shows the rankings of older IITs in the QS rankings of world engineering institutions for 2010, 2011 and 2012. Irrespective of what parameters are used to rank academic institutions, Harvard, MIT, Stanford, Oxford, Cambridge, etc. are among the top few. India did not appear even in the first 200. In the QS Rankings for 2011, all the IITs slipped from their position in 2010. In the QS Rankings for 2012, IITB, IITD and IITK slipped further. But IITD and IITK improved their rankings. India is the only BRIC country that has not found a place in the first 200. It is important for India to understand what it takes to achieve excellence and how to retain it decade after decade. Some of the desired actions that can be taken to improve the quality of engineering education in India are listed below. But in 2014 twenty Indian educational institutions have featured in the latest ranking of BRICS, ‘QS University Rankings: BRICS 2014’.

Five Indian Institutes of Technology (IITs) win places in the top 20. IIT-Delhi, IIT-Bombay, IIT-Kanpur, IIT-Madras and IIT-Kharagpur have made it to the list. IITs are again by far the most successful representatives of the country’s higher education system. The IIT Kharagpur has a higher proportion of PhDs among its staff than any university in the five countries, while another three Indian institutions feature in the top five on this measure. The Union Human Resource Development Minister presented the first copy of the ‘QS University Rankings: BRICS 2014’ to the Indian Prime Minister Narendra Modi on 18th June 2014. He identified the need to link research and education to the development needs of the country. He emphasised the need for India to evolve an independent ‘India Ranking’ metric which can then involve the SAARC nations as the existing systems are skewed towards western nations. The growing interest in international rankings is reflected in a sharp increase in the positions of some Indian institutions featuring in the BRICS ranking published by QS. The Indian Centre for Assessment & Accreditation (ICAA) is a not-for-profit organization formed with a vision ‘to help assist the inclusion of at least 5 Indian Universities in the Top 200 of the World University Rankings by 2025’. It helps the universities in India to progress up the ranks.

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A. Improving the institutional academic climate

Good teaching-learning practices, transparent teacher evaluation and reward system, encouragement for innovations and development work, sponsored research work, and institutional and individual consultancy work would change the total academic climate of an institute for betterment. Conducting the education programs for working professionals is another area which would add to this aspect of improvement. Computation facilities, laboratory and workshop facilities, library facilities need to be extended beyond the academic routine hours. Research work will get a boost if research scholars working for higher degrees are made available in the campus. A clear cut policy enabling consultancy work is framed by the institution. Internship during the course of study must be included in order to train the students to face the corporate world.

B. Effective curriculum implementation

Institutions need to design and develop curriculum implementation strategies such that responsibility and initiative in learning is gradually shifted to students with teachers playing the role of managing effective and efficient...
learning and creating opportunities for self learning and self pacing in learning. For bench marking best practices, teachers need to examine how curriculum is implemented in other professions like in medical profession, management institutions, etc. Where examples for bench marking are not available, institutions need to develop their own model and standards. For this, teachers would require exposure to modern industry and good training institutes. They also need to be taken for study tours to see best practices in themselves.

C. Industry and other institutions interaction

Marketing of product and services of the institute to the society has to be planned and implemented systematically. The responsibility of student’s placement in industry has to be jointly taken up by the head of the institute, training and placement officer, the heads of departments and the students. For an established institution, the old students, well places in industry, must be located and their involvement be planned. Networking with organizations and other institutions must be done for mutual benefits.

D. Students initiative in learning

Orientation program at departmental level explaining the structure of the programme and positions of the subject in the whole curriculum has to be explained to the students. The relevance of study of the subjects and their components have to be explained by teacher and by using experts from industry. Visit to application industries must be planned. Students have to be provided with details of the curriculum and other requirements. The skill set required for gainful employment have to be clearly explained to students preferably involving experts from industry. Guidance and counselling services to students have to be extended. Teaching-learning should be planned to include class-room interactions, emphasis on practical work, independent study, group projects, assignment, library study, feedback, etc.

D. Effective evaluation system

Student evaluation system must be valid, reliable and should be objectively designed. Emphasis should be on assessing the higher order cognitive skills like ability to think and apply, ability to analyze and synthesize, and solving problems. Evaluation of students other personality traits like ability to work in group and contribute, ability to self learning and communicating, etc. need also be taken care of in making assessment of students. Multiple evaluation tools like objective and short-answer type tests, quiz, seminars, group discussion, project report preparation and presentation, etc. may be included in student evaluation. At the university or board of examination level, there is need for developing model question papers, question banks, and table of specifications for setting question papers in various subjects. On the basis of these analytical points, action plan can be prepared for each of the activities at management level, teacher’s level and at the level of students. A monitoring mechanism must be included to evaluate progress and providing feedback.

VIII CONCLUSION

Creating world class education institutions and nurturing them is an exciting and challenging task. While India has created several (world) reputed institutions in diverse fields with the active support of the government their transformation into world class entities would need major policy initiatives as well as meticulous execution. Institutions must be provided granted affiliation only if they satisfy the requirements such as the infrastructure, qualified faculty and many others. Apart from finance and infrastructure, recognition from local, national, and international policy makers is extremely important as it brings confidence and encourages institutions to be proactive. Faculty, academics and research are the mainstay of any good institution. The faculty to student ratio should be improved to approach 1 to 15 for the under graduate courses so that faculty can concentrate well on each student to bring out the hidden talents in them. Motivating the students to take initiative in learning also plays an important role. Collaboration with the leading institutions and organisations will help in making the Indian engineering as world class. Internship during the course of study must be included in order to train the students to face the corporative world.

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