

Opportunities and Challenges for Engineering Education in India

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Abstract - The Engineering Education system in India has several distinctive features, such as huge size; considerable diversity of many types; several strengths and weaknesses; several policy pronouncements; several pending Bills; a small number of institutions of quality in a sea of mediocrity; the emergence of the private sector as a major player ; etc. There are several national policy initiatives for laying down the roadmap for the future, such as the National Policy on Education 1986, revised in 1992; the Science Policy Resolution, The Technology Policy Statement, The Science and Technology Policy, The Science, Technology and Innovation Policy; The Twelfth Plan Document ;National Knowledge Commission Recommendations; Yash Pal Committee Recommendations; National Higher Education Policy (RUSA) etc. With a change in government at the centre, it is hoped that several pending bills such as, establishment of National Council for Higher Education (NCHER); National Accreditation Regulatory Authority (NARA); Entry of Foreign Universities; etc will be cleared, and also the promises made in the poll manifesto would be acted upon. These are the emerging Opportunities for Change– for the better.

1. Introduction

The Engineering Education system in India has several distinctive features, such as(AICTE Approval Handbook , 2014-15):

- Huge size (3495 Engineering institutions, admission capacity of 1,761,976)
- Considerable diversity of many types (such as level -PG, UG, Diploma- rural vs urban, public vs private, etc. ;
- Several strengths and weaknesses;
- Several policy pronouncements;
- Several Bills in the Parliament;

- A small number of institutions of quality in a sea of mediocrity;
- The emergence of the private sector as a major player (about two thirds of the institutions are in the private sector); etc.

2. National Policy Initiatives

There are several national policy initiatives for laying down the roadmap for the future. The national S&T and Education Policies lay great stress on Science, Technology and Education as the principal instruments of change for achieving socio-economic development and a decent standard of living for the majority of the people. Human resource development, in particular the acquisition of the requisite technological knowledge and skills, has been recognized to be capable of making up for the lack of material resources.

2.1. The Scientific Policy Resolution

The National Scientific Policy Resolution was officially enunciated on March 4, 1958, setting forth the emerging role envisaged for science, both basic and applied, and indicating the Government's intention to support science and technology in order to 'secure for the people of the country all the benefits that can accrue from the acquisition and application of scientific knowledge'.

2.2. The Industrial Policy Resolution

The Industrial Policy Resolution dates back to 1956; it provided guidelines for the implementation of the policy related to import of technology and foreign investment. This policy has undergone a number of changes, but essentially demands that Indian firms that are to import foreign technology should set up

in-house R & D facilities so that imported technology is properly adopted and assimilated.

2.3. The Technology Policy Statement.

In 1983, the Technology Policy Statement was announced, with the basic objectives of 'development of indigenous technology and efficient absorption and adoption of imported technology appropriate to national priorities and resources'.

2.4. The Science, Technology and Innovation Policy

The Prime Minister of India, at the Indian Science Congress-2010 declared 2010-20 as the "Decade of Innovation" and constituted the National Innovation Council. The STI Policy 2013 is in furtherance of the declaration and aims to bring fresh perspectives to bear on innovation in the changing context. The policy thus seeks to focus on both people for science and science for people and combine the benefits of excellence and relevance.

2.5. The National Education Policies

Since independence, several working groups, commissions and documents have recognized that the achievement of economic and social development can be facilitated and expedited through proper education, and that human resource development has a multiplier effect on the utilization of all other resources. The Report of the Education Commission (1964-66) referred to education as the only instrument of peaceful social change.

The first National Education Policy was formulated in 1968, with the principal aim of creating an 'ethos that would produce young men and women of character and ability committed to national service and development'.

In August 1985, the Ministry of Education prepared a document entitled 'Challenge of Education – a policy perspective', which was widely circulated and discussed in several fora throughout the country. It resulted ultimately in the formulation of the National Policy on Education (NPE-1986).

As far as technical education is concerned, the 1968 Policy stressed its importance, but dealt with it briefly. The 1986 document, while recognizing the

significant contributions made by technical education to India's economic development, identified several issues requiring immediate attention: obsolescence of machinery and equipment, updating and up gradation of engineering curricula, technician education, inability to attract good teachers (20-30% shortfall, on the average), industry-institution interaction, lack of a work ethos in the majority of institutions, industrial investment in R & D, quality assurance in technical education, the complementary role of management education, etc. For the first time, the NPE-1986 brought technical and management education together. In order to ensure efficient implementation of plans enunciated in the national policy, it was followed up by a 'Program of Action', involving the constitution of 23 task forces.

The government has proposed to articulate a new National Education Policy any time now.

2.6. The AICTE Act

While the All India Council for Technical Education has been in existence for several years, in 1988 it was vested with statutory authority for planning, formulation and maintenance of norms and standards, funding of priority areas, monitoring and evaluation, and for ensuring the coordinated and integrated development of technical and management education. The AICTE Act defined 'technical education' to include programs of education, research and training in engineering, technology, architecture, town planning, management, pharmacy, and applied arts and crafts.

2.7. National Knowledge Commission Recommendations(NKC(2012)

The National Knowledge Commission (NKC) was constituted in June 2005 by the (then) Prime Minister Dr. Manmohan Singh, under the Chairmanship of Sam Pitroda, to prepare a blueprint for reform of our knowledge - related institutions and infrastructure which would enable India to meet the challenges of the future.

The Terms of Reference of NKC were:

- Build excellence in the educational system

to meet the knowledge challenges of the 21st century and increase India's competitive advantage in fields of knowledge.

- Promote creation of knowledge in Science & Technology laboratories.
- Improve the management of institutions engaged in Intellectual Property Rights.
- Promote knowledge applications in Agriculture and Industry.
- Promote the use of knowledge capabilities in making government an effective, transparent and accountable service provider to the citizen and promote widespread sharing of knowledge to maximize public benefit.

The National Knowledge Commission had a designated time-frame of three years from 2nd October 2005 to 2nd October 2008, which was extended to 31st March 2009.

At the heart of NKC's mandate are five key areas related to Access, Concepts, Creation, Applications and Services; how to build a knowledge society from these perspectives, with particular focus on access to knowledge. Under these five focus areas, the Report covered various subjects. In most of these areas, Working Groups, consisting of domain experts from the government, academia, industry, civil society, media and others were constituted to make the entire process democratic, transparent and participative. NKC has submitted around 300 recommendations on 27 subjects in the form of letters to the Prime Minister. These have been widely disseminated in its Reports to the Nation, seminars, conferences, discussions and covered by national and regional media.

The UPA's commitment to NKC's Vision is reflected in the 11th Five Year Plan adopted by the National Development Council. The Plan places high priority on education as a central instrument for achieving rapid and inclusive growth with specific emphasis on: expansion, excellence, and equity.

It was recognized that "there is still resistance at various levels in the government to new ideas, experimentation, process reengineering, external interventions, transparency and accountability, due

to rigid organisational structures with territorial mindsets. As a result, the real challenge lies in organisational innovation with new regulatory frameworks, new delivery systems and new processes. Implementation is the key in going forward to address the three fundamental challenges related to: demography, disparity and development". The National Knowledge Commission identified the role of innovation as one of the key factors in India's economic growth. "Innovation is a process to achieve measurable value enhancement in any commercial activity, through introduction of new or improved goods, services, operational and organisational processes. It is a significant factor in facilitating competitiveness, improvement in market share and quality as well as reduction in costs".

2.8. Yashpal Committee to advise on "Renovation and Rejuvenation of Higher Education" (Yash Pal 2012)

The Committee was originally supposed to review UGC/AICTE and various other councils connected with higher education. Expressed, and the overall implied, hope was that it might be able to suggest ways of moving our higher education to a more active and creative form. It was also felt that engaging with listing the limitations and faults of these two organizations would not be very productive, besides being very limiting. A few months down the line Yashpal suggested that the task might be made broader; that it should be asked to advise on "Renovation and Rejuvenation of Higher Education".

The basic elements of a new organisation of our higher education system involved the recognition that "a university should encompass all disciplines and their interfaces; the curriculum framework should recognize outside world and go across boundaries of disciplines; all higher education institutions should move in this direction; higher education institutions need to be accredited and supported; and for this we need a single Higher Education Commission (HEC). As for Performance Criteria, the Committee pointed out that "the current environment favors those

criteria which can generate enumerative data, such as the number of research papers published by the faculty in journals, the number of patents acquired, and so on. Criteria of this kind are convenient to use, but often end up becoming mechanical and lose their significance in the context of larger aims of education when the faculty's work gets delinked from national or social concerns and priorities". Taking a cautionary view towards such a possibility, the Committee proposed three parameters for evolving performance criteria:

- socio-cultural aims of higher education;
- academic excellence; and
- institutional self-reform

"The Constitution of India offered a framework for aims of education. The socio-cultural aims enshrined in the Constitution assign a transformative role to education".

2.9. *Rashtriya Uchchatar Shiksha Abhiyan (RUSA) – National Higher Education Mission (RUSA September 2013)*

"The XII Plan continues to maintain focus on higher education in the country, to make it more relevant to the global needs and to remove the inequities in access to education amongst various social groups. Such objectives are sought to be realized by providing adequate inputs and implementing much needed governance and regulatory reforms in the sector".

"With respect to the planning and funding approach, four key changes are envisaged:

1. funding will be more impact and result oriented,
2. various equity related schemes will be integrated for a higher impact,
3. instead of unplanned expansion, there will be a focus on consolidating and developing the existing system by adding capacities; and
4. there will be a greater focus on research and innovation".

"A paradigm shift proposed by the Planning Commission is in the arena of funding of the state higher education system. Strategic funding of this

sector has been strongly proposed in order to make a marked difference in the overall resource endowment for the state higher education sector". RUSA recognized that "there are four broad categories of higher education institutions in India: centrally funded institutions, state funded institutions, deemed institutions and private institutions". "While the centrally-funded institutions (Central Universities, IITs, NITs, IISERs, Institutes of National Importance etc) receive generous funding from the center, they have a limited coverage in terms of enrollment. About 94% of the students enrolled in government funded (48% of total enrolments) or government controlled private institutions come under the state higher education system". "Most private education institutions (52% of all enrolments) are affiliated to state universities and come under their academic and administrative control". Thus, it was stressed that "any efforts for development in this sector must recognize the importance of state higher education institutions and aim to improve their status".

There are 3064 state universities and about 8500 colleges that can be covered under RUSA. "The funding will be provided in the (Center: State) ratio of 90:10 for Special Category States ie North-Eastern States, Sikkim, J&K, Himachal Pradesh and Uttarakhand and 65:35 for Other States and UTs. Funding will be available to private government-aided institutions also, subject to their meeting certain pre-conditions, for permitted activities based on pre-determined norms and parameters".

"The key objectives of RUSA are to improve access, equity and quality in higher education through planned development of higher education at the state level. Such planning will include creating new academic institutions, expanding and upgrading the existing ones, developing institutions that are self-reliant in terms of quality education, professionally managed, and characterized by greater inclination towards research and provide students with education that is relevant to them as well the nation as a whole".

3. Quality Assurance and Accreditation Mechanisms

There are two major national quality assurance instruments in Higher and Technical Education, which incidentally were established in the same year, viz. 1994:

3.1. National Board of Accreditations (NBA)

This was originally conceived as one of the several Boards of the All India Council for Technical Education (AICTE). NBA in its present form came into existence as an autonomous body with effect from 7th January 2010. NBA accredits not only undergraduate programs, but also postgraduate and diploma programs. The accreditation processes are designed broadly along the lines of ABET processes, but adapted to suit local circumstances and context. This is becoming particularly useful now when India is seeking to become a member of the Washington Accord.

3.2. National Assessment and Accreditation Council (NAAC)

This was set up as a Society by the University Grants Commission (UGC): NAAC covers essentially general “non-professional” education provided by universities and autonomous colleges. Some engineering colleges, however, have also sought and obtained institutional accreditation from NAAC.

There are other Quality Assurance instruments, as well:

3.3. ISO-9000

Following the corporate sector, several engineering colleges have obtained ISO-9000 certification from the relevant agencies.

- Magazine Rankings

Several magazines in India publish annual rankings of engineering institutions (T-schools) and management institutions (B-schools), such as for example, India Today, Outlook, Dataquest, Business World, Business Today and Business India.

- National Accreditation Board for Testing and Calibration Laboratories (NABL)

The Department of Science and Technology assesses laboratories which undertake testing and calibration certification through NABL.

4. Opportunities and Challenges for Engineering Education in India (Natarajan and Vedula(2010)

4.1. The Need for a Change in the Engineering Education Paradigm:

Several fundamental changes have taken place in the recent past, such as: globalization; the concept of sustainability; rapid advances in S&T, especially in fields such as I.T., biotechnology, materials technology, etc. New processes for the development, utilization and expansion of knowledge have raised questions of whether and to what extent the qualification, education and training; and employment of engineers; need to be adapted in order to meet and master these new challenges and requirements. Challenges for engineering education and the engineering professions have also arisen from technological and organizational change and the internationalization of business.

4.2. The Shortcomings of Current Curricula and Suggestions for Reform :

The core difficulty is in taking into account the heterogeneity of work settings of engineers. The US curricula are criticized for tending to be geared to the waning model of the large-scale industrial research lab, and for failing to account for the changing needs of most companies.

The requirements of reformed curricula are :

- More interdisciplinary elements and interfaces
- Early industry exposure through project-based learning and internships
- Management knowledge and business process skills
- Opportunities for improving foreign language skills (including foreign experience)
- Interpersonal skills training, and development of a sense of social responsibility.
- More flexible course and examination requirements to facilitate joint-programs with universities / polytechnics abroad.

The unresolved question is: how to accommodate the additional learning requirements in re-designed engineering curricula without prolonging studies or losing depth.

5. Drivers of Change in Higher Education (Natarajan and Shetty(2012))

There are several Drivers of Change in Higher Education:

- Quality can be driven by Regulations and Accreditation:
- AICTE Regulations demand fulfillment of pre-requisites, such as Faculty – both numbers as well as qualifications; Infrastructure, etc.
- Accreditation is a powerful driving force for change as far as Quality is concerned
- The mandatory peer review mechanism enables an outside-in view of the Institution
- The Washington Accord and ABET – prescribed Outcomes-based Teaching, Learning and Assessment Paradigm are driving several changes in our Technical Institutions.

Of course, there are other change agents, as well, such as, for example, the founding mandate, national and state policies, perspective plans, and leadership. There are several enablers and constraints as well: availability of Resources – human, physical and financial --, the ecosystems in the institution for creating and sustaining a culture of scholarship, quality, excellence, innovation, and also, World University Rankings. Ellen Hazelkorn, in her recent Book, has affirmed that “HEIs are responding to league tables and rankings (LTRS), which are having an impact or influence — positive or perverse — on institutional behavior, decision-making and actions”.

6. Some Major Issues of Concern(Natarajan and Anandkrishnan(2010))

Here is a list of some current issues of concern

6.1. National Issues

- Regional Imbalance in quantitative expansion
- Small proportion of Institutions of quality; there are no Indian Institutions in the top 100 world-class university rankings.

- Even within states, institutions are concentrated in the vicinity of metros/cities; not much demand in rural institutions.
- Manpower assessment and planning are largely absent, both at the national and state levels

6.2. Institution-related

- Self financing institutions depend solely on student fees, and hence fees are high.
- Most of the Institutions are only engaged in Teaching; not much Research, Consultancy, Industry-Interaction
- While institutions of excellence resist quantitative expansion, the majority of institutions clamor for more branches, more seats
- There is a tremendous scarcity of academic leadership, both at the institutional as well as departmental level. Academic administrations largely learn on the job-and learning involves making mistakes.
- Commercialization (for-profit institutions)

6.3. Industry – related :

- Industry does not value PG qualification
- Employment generation is not commensurate with out -turn of graduates.

6.4. Faculty and Student – related:

- Lack of adequate and well-qualified faculty
- A large proportion of faculty do not possess PhD/ M.Tech qualification:
- We don't produce enough Ph.Ds/MTechs annually
- PhD/MTech intake capacity is small (while there has been a rush for quantitative expansion at the UG Level, there is no corresponding enthusiasm for such expansion at the PG level, for obvious reasons
- Graduates are not attracted to the teaching profession, and hence there is not much demand for PG qualification
- The QIP (Quality Improvement Program) capacity is not significant.
- In the prevalent affiliating system, the role of the Teacher is relegated to a minor one; curricula remain un-updated for long periods;

while international and global practices employ innovative ET and IT tools to improve teaching effectiveness, we are still laboring with out-dated teaching techniques and systems.

- Student projects are largely inappropriate, ineffective and un-imaginative

7. Conclusion

The Higher and Engineering system in India is undergoing several transformative changes, as a result of both external and internal factors. Especially with a change in the government at the centre, there are many expectations, although at the present time, there is continuity of several policies.

This Paper summarizes several opportunities and challenges ahead for higher and engineering education in India.

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