World Transactions on Engineering and Technology Education
Vol.2, No.2, 2003

The internationalisation of engineering education in India: a case of Maharashtra State

Arun S. Patil

Monash University
Melbourne, Australia

ABSTRACT: Engineering and technology education has a direct impact on the industrial growth, infrastructure development and socio-economic advancement of a country. In a rapidly moving phase of societal networking, higher technical education should follow the general trends of global connectivity and collaborations. The article presents an overview of the engineering and technology education in India with the present scenario of the internationalisation of engineering and technology education. The paper also outlines briefly the structure and methodology of engineering and technology education in the state of Maharashtra with some statistical data. The necessity and future benefits of international networking and collaboration in the field of engineering and technology education of a country has also been explained. A three-tier strategic model of networking and collaborative programmes at the local, national and international levels of higher technical education, with special emphasis on the Maharashtra State of India, is proposed and its functions described and elaborated.

INTRODUCTION

> *There is an urgent need to upgrade the quality of technical and engineering education in India to provide students with a virtuous cycle of opportunities. In this cycle, good training leads to better jobs, better jobs lead to increased productivity and increased productivity leads to accelerated growth of the Indian economy which, in turn, impacts poverty reduction* [1].
>
> Shashi Shivastava
> Senior Education Specialist with the World Bank

Society expects higher education to develop technology, productivity, international competitiveness and economic development. Technical education has a direct impact upon industrial growth. It is a basic and essential input for national development and for strengthening industry, economy and the quality of life of the people [2]. A nation with more informational sources will rank fairly high in terms of economic growth.

As per the need for global technical advancements, international networking and collaborations are key factors in the development of engineering and technology education. Higher education will follow the general trends of decentralisation with global connectivity, continuous change and the increasing use of information technologies [3].

The increased level of internationalisation of engineering education has provided academic institutions with new opportunities for further cooperation in the international arena by building new, and expanding existing, regional and global engineering education initiatives. International leading universities and institutions are opening up their campuses in agreement with local, as well as international, organisations for academic and research collaborations.

This article outlines the growth profile in engineering and technical education in India and also describes the importance of international collaborations and the networking of engineering education. A strategic model for the networking of higher education is also proposed in this article.

PRESENT SCENARIO

Engineering education in the Asia-Pacific region is developing rapidly due to growing demands of professional engineers and skilled technicians. With the second largest population in the world, India is characterised as one of the rapidly expanding economies of the world, as having a stable and democratic political system and as having made significant progress in many human endeavours [4].

It has been observed that India has made considerable progress regarding the development of engineering and technology education over the last 50 years. At the time of independence (1947), there were only 38 degree-level institutions and 53 diploma-level institutions, with an intake capacity of 2,940 and 3,670 students respectively [5].

India has a great potential of technical labour with 1,208 approved degree-level engineering institutes and an intake of 359,721 students, as well as 1,224 approved diploma-level engineering institutes with an intake of 188,300 students as of March 2003 [6]. These institutes are located all over the country and approved by a statutory council named the All India Council for Technical Education (AICTE), which has been established in order to properly plan and coordinate technical education in the country.

Table 1 gives the regional distribution of the number of approved institutions and student intake for both degree- and diploma-level engineering courses. It clearly shows the regional imbalance, with a greater number of colleges in the south and southwest regions compared to the other regions.

Table 1: Regional distribution of the technical education infrastructure in India.

Region	Degree Level		Diploma Level	
	No. of Inst.	Student Intake	No. of Inst.	Student Intake
Central	81	25,914	98	19,830
East	99	24,019	97	14,099
North	99	26,356	140	17,003
North West	119	32,042	150	25,400
South	471	145,372	310	62,311
South west	184	58,243	251	11,294
West	154	47,775	178	38,365
Total	1,208	359,721	1,224	188,300

THE IMPACT OF GLOBALISATION

Many nations, including both developed and developing countries, are taking steps to reform their higher education systems with possible formulations of collaborative and networking projects. The Government of India has already boosted the quality and efficiency of engineering, technical and vocational education through World Bank-supported projects and various collaborative programmes. India has become a global centre for software research and development, along with other disciplines in engineering and technology.

The globalisation process of the Indian economy has set in motion the gradual globalisation of its education. Due to the economic liberalisation in foreign exchange control, large numbers of students are migrating to foreign universities, apart from the lack of quality in higher-technical education. Many foreign institutions have entered into collaborations with higher and technical education. Also, many foreign governments and financial agencies are facilitating student exchanges, faculty exchanges, research collaboration, etc, under these collaborative programmes.

However, there is a distinct lack of collaborative projects that are dedicated to the retrieval and dispersal of information in engineering education. This could be very well fulfilled by collaborative partnership projects with the UNESCO International Centre for Engineering Education (UICEE), the world's only centre of its kind in engineering education.

ENGINEERING EDUCATION IN THE STATE OF MAHARASHTRA

The State of Maharashtra, which is a pioneer in technical education, contributes more than 50% to this educational achievement. Since the establishment of a School of Engineering in 1854 at Pune, the growth of technical education has been amazing in Maharashtra state. Table 2 shows the present intake in all engineering and technology areas.

Internationalisation has brought about the increasing influence of IT and advanced communication technologies all over the world. The nation with more informational sources will rank quite highly as regards economic growth. India should accept this policy of international networking and collaboration as early as possible in order to rank in the cadre of information rich countries.

Table 2: Present intake of engineering, technology and management courses in the Maharashtra State [7].

Course / Year	Diploma in Engng. and Technology		Degree in Engng. and Technology	
	No. of Institutes	Intake	No. of Institutes	Intake
1978	28	5,145	16	2,642
1988	127	23,436	76	14,275
1995	160	30,000	94	22,740
1998	154	33,000	109	25,314
2000	170	34,295	129	38,939
2001	170	35,440	141	41,160

INTERNATIONAL NETWORKING

Universities in developing countries have difficulties in meeting industry demands for dynamic and flexible education programmes, as they are unable to fill the gap between demand and supply. These universities are required to consider the structure of their programmes, the delivery method of courses and teaching techniques by striking up collaborations with institutes in developed countries and industries [8].

Many universities and organisations see such collaborations as a potential source of extra income. Financial benefits to the university/institutions and technology benefits to industry are positive outcomes from international collaborations and networking. Not only that, but international cooperation between academic institutions can be very beneficial for these institutes and their home countries; hence, international links must be established at the highest administrative levels in order to improve the level of engineering education in the country.

BENEFITS OF INTERNATIONAL COLLABORATIVE PROGRAMMES

International networking and academic collaborations are key factors in developing engineering education, as well as sharing physical, human and other resources for mutual benefits and the technical workforce development of any nation. This also helps in the transfer of information and knowledge between developed and developing countries, such as India.

Apart from the military, the most active and long-term users of the Internet are universities. The Web is an ideal platform for educational purposes, but also has other academic uses with regard to research and publication [9].

The benefits of such collaborations can be listed as:

- Establishing and developing connections with the best-known universities in the world for institutional priorities and strategies;
- Providing research support and cooperative research in various fields;
- Promoting academic excellence in the field of engineering and technology education;

- Establishing modern facilities and infrastructure for research and development activities;
- Providing excellent linkages with local industries and the transfer of technology between institutions and industries.

RECENT ADVANCEMENTS

India's technical workforce has been increased considerably over last three decades, which has over 3 million. A recent literature research shows that India is home to the largest pool of English speaking scientific workers, next to the USA [10]. Considering the potential benefits of the technical education in India and the impact of technical education on the productivity and competitiveness of the country's economy, the Government of India has already started to implement several technical education improvement programmes. At the same time, these types of improvement and collaborative programmes are also undertaken within various states of the country – including Maharashtra.

Recent examples of these advancements in India, as well as within the State, are described below.

Technical Education Improvement Projects in India and Maharashtra State

Recent technical education improvement projects in India and Maharashtra State include the following:

- At the end of 2002, India announced a programme to improve technical education within the country. The programme includes Rs. 15.5 billion World Bank aid, which will be utilised to upgrade engineering institutes to international standards [11]. This is an extension of various projects announced by the Indian Government to internationalise and standardise engineering and technical education in the country. Under this programme, about 17-20 engineering institutions will be developed as *centres of excellence* or *lead institutions*. It is envisaged that these lead institutions will be networked with local institutions for further improvement of technology education in the neighbouring regions of the lead institutions [12]
- One of the programmes of the Technical Education Development Project series was announced in 2000 for the underdeveloped and geographically remote states of the country. The project, called *Third Technician Education Project*, extends on the positive results of previous projects to other states and is supported by World Bank financing through a US$64.9 million credit to improve technical education in underdeveloped states [13]. The project also includes the establishment of six new polytechnic institutes, as well as the strengthening of existing polytechnics with the introduction of various programmes.
- Recently in Maharashtra state, the UNESCO International Centre for Engineering Education (UICEE) signed two Memoranda of Understanding (MoUs) in Mumbai, in order to build and establish potential links, collaborations and partnerships with the UICEE. The two agreements have been signed with the Hyderabad (Sind) National Collegiate Board and with the Maharashtra State Board of Technical Education (MSBTE). Under these two agreements, it is proposed to establish two satellite centres at these institutions in the State [14].

Although, several collaborative programmes have started to be implemented in India, the implementation of such projects is very slow, especially when compared to the speed of globalisation around the world. There is a lack of a standard and uniform strategy that can be used as a model and which can fit into any structure of the collaboration. Every state has individual policies and formula regarding higher education and collaborations, which can be a hurdle for several international institutions and organisations wishing to collaborate in India on different projects in more than one state in India. This has also resulted in a serious and urgent need to design a uniform model for collaboration.

EDUCATION AS AN ECONOMIC SOURCE OF INCOME

The long and auspicious history of education in India has its roots going back to the establishment of the first university in the world some 2,700 years ago, at Takshashila (Taxila), in the northwest part of India [15]. Since then, India has always been at the forefront in education in almost every discipline, including science and technology. The growth and advancement of science and technology education also has its foundations in the ancient period of India with several examples, such as: the invention of zero and evidence of plastic surgery by the famous *father of surgery*, Shushruta, around 600 BC.

The growth of higher education and the influence of the global economy have influenced the Indian education system over the last few years. Countries like Australia, the UK, Canada and Singapore have already developed *education* as an important source of income. This has led to the establishment and development of several collaborative projects between universities internationally.

Indeed, recent literature research shows that thousands of students from India are enrolled in various higher education institutes all over the globe; however; this mobility takes place in one direction only. For instance, the highest number of foreign students enrolled in various universities of the USA is from India [16]. At the same time, around 150,000 students from the USA are mobilised and enrolled outside in various countries around the globe, yet India is not even in the list of the first 20 countries. The reasons for this can be listed as follows:

- Lack of infrastructure;
- Insufficient levels of advanced facilities and equipment;
- Lack of proper design of curricula;
- Lack of uniformity (policy, infrastructure, routine administration, etc) among all universities;
- Rigidity in government policies;
- Lack of finance to support advanced projects due to poor industry linkages;
- Insufficient training after completion of the course;
- No proper placement facilities.

CURRENT SCENARIO

Although the growth of technical education in India has increased dramatically over last two decades, the quality has been somewhat fragmented. There is a mismatch between the technical skills of graduates and India's industrial needs. This scenario is much more pronounced in the rural

and remote places of several states. For instance, there are several private engineering and technology institutions distributed all over the State of Maharashtra, yet most of the State's industries are centralised around the cities of Mumbai and Pune.

All Indian states need to collaborate with institutions around the world so as to improve the level of engineering and technology education within the state, as well as enhance the economic situation in the state.

This article proposes a strategic model in this direction. The structure and methodology of this model is described in the following section.

PROPOSED MODEL

The engineering and technology education in the State of Maharashtra is generally imparted at three different levels, namely:

- Diploma-level courses;
- Undergraduate courses;
- Postgraduate courses.

Hence, the proposed collaborative model of engineering education is a Three-tier Collaborative Project in Engineering and Technology Education (TCPET), consisting of three important levels of collaborations as shown in Figure 1. The methodology of the proposed model is described in further below.

METHODOLOGY

The methodology utilised in the TCPET model has three different levels of integration, described in further below.

Level A: Collaborative Programmes for Engineering Diploma Courses

At Level A, most of the collaborative projects can be designed and implemented for diploma-level courses with the involvement of several polytechnic institutions. These include both Government-funded as well as privately managed institutions in the State. The target collaborative agencies may be institutions from around the globe that can impart the same level of courses. For instance, Tertiary and Further Education (TAFE) institutes in Australia and New Zealand.

Level B: Collaborative Programmes for Undergraduate Engineering Courses

At Level B of the model, most of the engineering and technology colleges in the state, including both Government-funded and privately managed institutions, can be selected for possible alliances with renowned undergraduate institutions worldwide, including universities and several schools. This programme can further be divided into different sections according to individual disciplines, such as digital electronics, mechatronics, robotics, remote sensing, etc.

Level C: Collaborative Programmes for Postgraduate Engineering Courses

The level of collaboration in Level C of the model can have several joint programmes for the postgraduate departments of state universities, such as University Department of Chemical Technology (UDCT), Mumbai. Other examples include master and doctorate programmes in different disciplines from various universities in the state. The most important feature of this level is the involvement of Indian Institutes of Technology in the state, such as the Indian Institute of Technology (IIT) Mumbai.

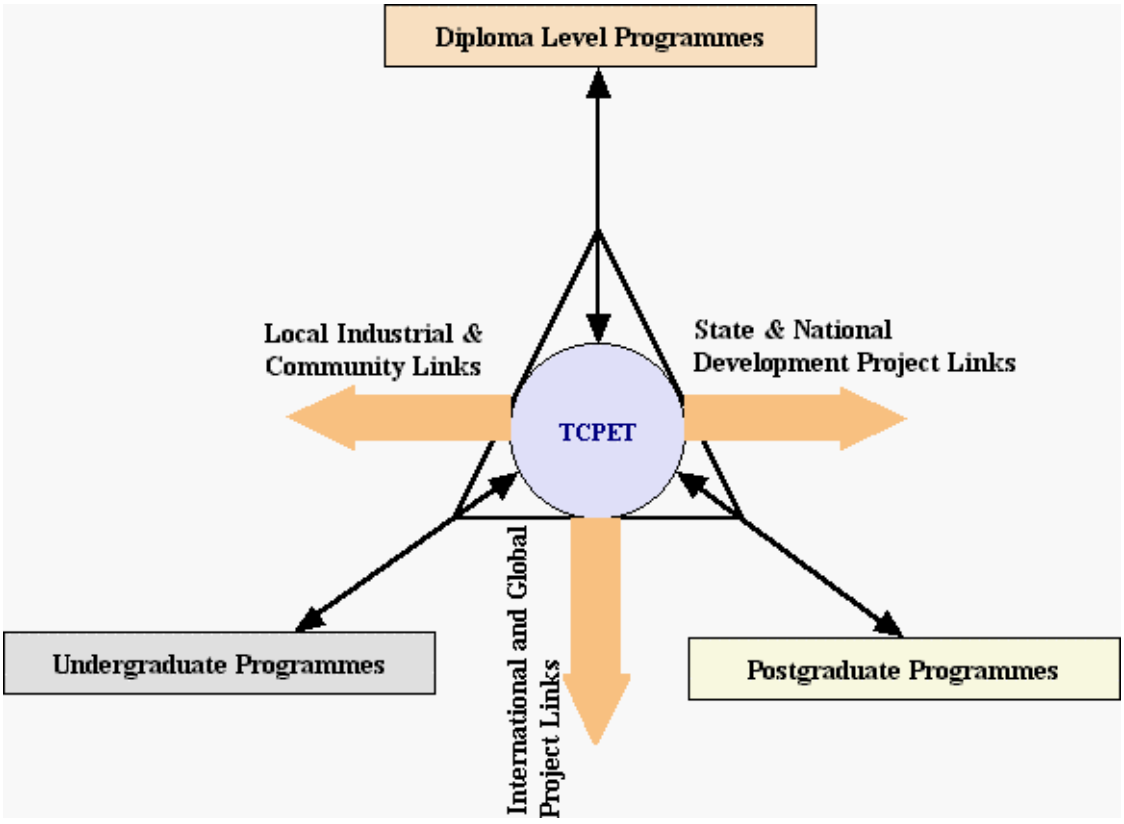

Figure 1: The architecture of the proposed TCET model.

WORKING OF THE MODEL

The proposed model must have again three core levels of integration, as listed below:

Local Level

The local level includes links with local industries and community organisations in order to transfer knowledge and formulate research and development activities within the local area. For example, the institution located in a remote area of the state must have links and contacts with local industries via various governmental and semi-governmental organisations, such as Maharashtra Industrial Development Corporation (MIDC), the Chamber of Commerce, etc. This will also help in expanding industrial know-how and in the exchange of two-way information between institutions and local industries.

State and National Level

The model can also establish the required links between various associations at the state and national levels. Examples of this include links with a state governmental organisation, such as Maharashtra Knowledge Corporation Limited (MKCL) or with important national level organisations like the Oil and Natural Gas Commission of India (ONGC), etc. This will help in the exchange of ideas and research between the institution with various important organisations at the state and national levels.

International Level

An international level of integration is possible with various collaborative and joint programmes with international organisations worldwide, such as the UNESCO International Centre for Engineering Education (UICEE). This will help in upgrading and exchanging information with various international institutions worldwide.

After finalising the basic structure and strategy of the TCPET, several projects can be organised and carried out within these three levels of integration. Examples of these programmes are described below.

COMPUTER-ASSISTED COURSES

It would be possible to offer a computer-assisted course in engineering education for those teachers involved with diploma, undergraduate and postgraduate engineering curricula in the state. Such a course could be organised in various regions of each state's Directorate of Technical Education, which may be one of the future ongoing activities of the collaboration.

The UICEE course, entitled: *The Application of Computer-Assisted Training Programs in Engineering Education*, which was developed and tested by the UICEE under the sponsorship of UNESCO, may be the right proposition for this endeavour [17].

TEACHERS' TRAINING PROGRAMMES

Under the Indian government's quality improvement programme for technical education, Technical Teachers Training Institutes (TTTIs) have been established in different regions of India. The objectives of these training institutes are to plan, design, develop and evaluate quality-training programmes for technical and vocational teachers within that region.

However, considering the growth of technical education in the country in general, and in the State of Maharashtra in particular, there is an immediate need for the establishment of an advanced training institute for undergraduate and diploma-level teachers.

Again, the Graduate Courses in Engineering Education (GCEE), devised under the auspices of the UICEE, may be possible to be implemented for this purpose in the state of Maharashtra with the involvement of other UICEE partner institutions. A training centre can be established in Mumbai where teachers from several engineering and technology institutes within the State can attend the training programmes [18].

INTERNATIONAL CONFERENCES

India, with its astonishing topographical variations and its strong cultural diversity, is often viewed as an attractive land with its impressive local flora and fauna for international visitors. Similarly, India has also become the focus point for several international educators, investigators and economists, due to its growing economy and advanced system of education.

Considering these important factors, it is also envisaged to organise and stage several important meetings in the State under this collaborative project. For instance, one such forthcoming event will be the *7th UICEE Annual Conference on Engineering Education*, which will be held in Mumbai between 9 and 13 February 2003. This prestigious gathering is being organised under the theme of *Educating for the Global Community* and will be carried out in parallel with the *1st Annual Conference of the Monash Asia Institute* (MAI). The MAI is based at Monash University, Melbourne, Australia [19].

Due to the location of the Conference in Mumbai, which is one of India's important and prime business, education and financial centres, it is anticipated that the Conference will further enhance UICEE's links and networks, and will set the stage for more innovative and collaborative ventures.

CONCLUSIONS

The effective use of internationalisation in the technical education sector of the country in general, and the State of Maharashtra in particular, can change the economic scenario at both the national and international levels. The types of collaborative projects discussed here will help in developing proper coordination and linkages between local industries, governmental agencies and educational institutions. This will also lead to the transfer of information in the important areas of information technologies and multimedia to developing countries worldwide.

For instance, it is envisaged that the UICEE's linkages on the European continent will give Indian institutes, such as Indian Institutes of Technology (IITs) and State Engineering Institutes, the opportunity to explore possibilities for cooperation beyond existing collaborative programmes, such as sandwich types MTech programmes in engineering, as can already be found with Germany.

It is necessary in today's world to remain competitive in the emerging global economy and the internationalisation of engineering and technology education. Hence, it is essential for engineering and technological institutes and organisations to be competent in abstraction, systems thinking, experimentation and collaborations, and to become familiar with world class engineering education. As such, several actions facilitating such developments must be undertaken in this era of globalisation.

International networking and academic collaborations are the key factors in developing engineering education, as well for sharing physical, human and other resources for mutual benefits and the technical workforce development of any nation. This article describes the objectives and benefits of collaborative projects in engineering education. The article also gives a strategic model of collaborative projects in the State, namely TCPET. The methodology and working of this proposed model has also been described in this article.

ACKNOWLEDGEMENT

The author would like to acknowledge Mr P.S. Revankar for his timely advice in the original version of this article, which was submitted and published in the *Proceedings of the 3rd Global Congress on Engineering Education*, held in Glasgow, Scotland, UK, between 30 June and 5 July 2002.

REFERENCES

1. India: World Bank approves credit for improving technical and engineering education. Press Release No: 2003/142/SAR, 14 November 2002 (2003), http://www.worldbank.org
2. Patil, A.S. and Pudlowski, Z.J., Economic globalisation and higher technical education: an Indian perspective. *Proc. 5th UICEE Annual Conf. Engng. Educ.*, Chennai, India, 159-162 (2002).
3. Devon, R. and Liu, J., Global change and the management of engineering education. *World Trans. on Engng. and Technology Educ.*, 1, **1**, 85-89 (2002).
4. Patil, A.S. and Pudlowski, Z.J., The need-based curriculum design for applied physics in engineering diploma courses: a case study of Maharashtra state in India. *Proc. 3rd UICEE Annual Conf. in Engng. Educ.*, Hobart, Australia, 301-303 (2000).
5. Patil, A.S., Engneering and technical education in India - current issues and trends. *Proc. 1st Asia-Pacific Forum on Engng. and Technology Educ.*, Melbourne, Australia, 172-174 (1997).
6. All India Council for Technical Education (AICTE), http://www.aicte.ernet.in/aicte/engg.htm
7. Directorate of Technical Education, Maharashtra State (DTE), http://www.dte.org.in/dteinfo/about.asp
8. Pandu, D.A. and Sharma, S.C., Development of engineering and technology education through international collaborations. *Proc. 2nd Global Congress on Engng. Educ.*, Wismar, Germany, 349-350 (2000).
9. Zakis, J.D. and Pudlowski, Z.J., The World Wide Web as universal medium for scholarly publication, information retrieval and interchange. *Global J. of Engng. Educ.*, 1, **3**, 259-267 (1997).
10. http://www.iciciknowledgepark.com/thepark/park.asp
11. Education India NEWS: Rs 15.5 billion programme to improve technical education, http://desitalk.newsindia-times.com/2003/01/03/campus-16-foot1.html
12. *Indian Society for Technical Education (ISTE) Newsletter*, 22, **6** (2002).
13. http://www4.worldbank.org/sprojects/Project.asp?pid=P050658
14. *UICEE Newsletter*, 10, **1**, 2 (2003).
15. http://www.indiaoz.com.au/hinduism/articles/amazing_science_3.shtml
16. Patavardhan, B., Journey of higher education. *E-Sakal*, Marathi newspaper (2003), http://www.esakal.com/static/sr_prasangik15.html
17. Pudlowski, Z.J. and Hadgraft, R.G. (Eds), *The Application of Computer-Assisted Training Programs in Engineering Education*. Melbourne: USICEE (1996).
18. Pudlowski, Z.J., A Draft Proposal: Graduate Courses in Engineering Education (GCEE) (1999), http://www.eng.monash.edu.au/uicee/activites/gcee.html
19. http://www.eng.monash.edu.au/uicee/meetings/7thUICEE.html