# *GLOBAL CONVERGENCE TO IMPROVE THE INTERNAL QUALITY ASSURANCE FOR POST GRADUATE ENGINEERING PROGRAMMES*

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***Abstract***

In the interdependent world, the global industries have started establishing new production units in fast developing countries in Asia. They not only establish manufacturing industries but also starting research and development centers utilizing the quality of postgraduate students and research scholars. The autonomous colleges and deemed universities can develop industry relevant interdisciplinary and multidisciplinary postgraduate programs to meet the growing demands not only from the ever growing engineering colleges but also fomr global industries. Hence, these institutes have to consider global convergence to improve the internal quality assurance for these programs and focus on the following eight factors selected for accreditation: i) Students, ii) Program educationalobjectives, iii)Student outcomes, iv) Continuous improvement in program planning and implementation, v) Curriculum, vi) Faculty, vii) Facilities, and viii) Institutional support.

**Keywords:** Global convergence, internal quality assurance, factors for accreditation, assessment of support system

## *INTRODUCTION*

In this globalized economy, the countries which take initiatives to develop internal quality assurance for post graduate programs to improve student learning outcomes, transferable skills, mentoring,providing infrastructure for developing industry relevant high end programs and consultancy services not only attract MNCs for manufacturing new products but also offer competent engineers and scientists for design and research works**.** India has to catch up through an endogenous process by improving domestic technological capabilities**.**India has emerged as a center for prototype design and manufacturing**.** As per the Washington Accord, the engineering programs are to be accredited and AICTE has come with National Accreditation Board which evaluates the post graduate programs offered. ABET (ABET,2013, New Mexico State University, 2012, GAC)[36] considered eight criteria as follows: 1.Students, 2. Program Educational Objectives, 3. Student Outcomes, 4.Continuous Improvement,5.Curriculum, 6.Faulty, and8. Institutional support. The post graduate engineering programs have to meet the prescribed standards in these eight areas.

**Mission statement**

Every university and autonomous engineering college should create mission statement so that all activities could be planned around achieving the stated mission.

### *Needs for Post graduate Programs in Applied Science, Engineering and Technology*

In the interdependent world, the transnational corporations (TNCs) always look for countries where they can get excellent high end applied scientists, engineers, technologists who can take up challenging investigations, analyses,

design, production of prototypes using advanced IT enabled systems, and simulated processes. Many well- known enterprises like GE have established their design centers inBangalore. Many more companies are establishing their design centers in Hyderabad and Chennai. In addition there is a heavy demand for postgraduate and doctoral engineers and technologists to man the new departments of engineering colleges and deemed universities. The well established and administered engineering colleges have been recognized to offer post graduate and doctoral programs under autonomous status. Hence they can take up more interdisciplinary postgraduate programs in collaboration with the industries which are looking for industry specific high end design engineers. This paper provides various proven initiatives in establishing interdisciplinary and multidisciplinary industry specific post graduate and doctoral programs.

***Program Educational Objectives***

The institutions have to develop program educational objectives for each program. It should clearly provide guidelines for developing needed courses; build assignments, projects, and industrial training so that the graduates can acquire the needed competencies.

***Process for review of the Program Educational Objectives***

For every program the institutes could establish the following:

- Curriculum Committee/ Board of Studies
  This could be consisted of Senior Professors, Senior Engineers from industry and Scientists from Research and development Labs.
- Assessment Committee
  This could be consisted of employer's representatives, alumni and senior faculty from the universities.
- Program Advisory Board
  This could be consisted of members representing the industrial associations, and the Head of the Department.

***Center for Excellence***

The autonomous engineering colleges and deemed universities have very high potential to become centers for excellence in selected sector. The strength gained by offering post graduate programs would help them to start consultancy centers and take sponsored research and development works. Such centers could be further developed into innovation centers. Development of interdisciplinary and multidisciplinary post graduate programs would further strengthen the activities and the innovation center could take up many projects under collaboration with TNCs.

***Expected Contribution to National Economy through Human Capital***

In the next twenty years the growth in many sectors, digital technology will create many surprising impacts. Most of the industries would utilize robots in the fabrication, assembly and packaging. Many traditions jobs will be taken over by the robots. Hence, there is a need for vigorous focus on IT enabled design, manufacturing and maintenance. The post graduate programs could focus on these aspects otherwise the fast growing universities in China, Japan, South Korea, and Hong Kong would supersede the Indian engineering education. The modern engineering universities

in these nations have very strong linkages with global universities and industries. Now many IITs have started creating linkages with many research universities which have shown keen interest in developing cooperation with IITs. Hence, initiatives could be strategically planned by the outstanding autonomous engineering colleges and deemed universities.

***Objective***

The objective of this article is to review these eight criteriaand to suggest suitable initiatives which could be taken by autonomous colleges which are well recognized based on their academic performanceand continuous research work done. The suggested initiatives arecross checked through various global research works done in these areas by the research scholars. It is further suggested that the managements have to plan adequate participation of the clients, students, faculties and administrators. The existing autonomous colleges can utilize the new environment and grow as centers of excellence(Thanikachalam.V, 2005 [61, 62]).

**Critical Analysis of Factors Considered for Accreditation**

Eight factors are considered ABET accreditation for any program. The factors considered by NBA process of AICTE have been merged with ABET criteria. The departments have to make sure the status of the factors should be above the expected standards so that accreditation is possible. One simple method is to do self - evaluation and identify the weak factors and plan to improve before submitting the report to the accreditation agency. The combined factors are presented in Table.1.

Table-1 Status of the factors considered for accreditation

| S.No | Factors considered for Accreditati-on | Curre-nt Status | Expect-ed Status | Existing Bench Mark |
|---|---|---|---|---|
| 1 | Students and Students'Performance | | | |
| 2 | Institutional Mission, Vision and Programme Educational Objectives | | | |
| 3 | Programme/ Students Outcomes | | | |
| 4 | Continuous Improvement in Attainment of Outcomes | | | |
| 5 | Program Curriculum | | | |
| 6 | Faculty Contributions | | | |
| 7 | Facilities and Technical Support; Academic Support Units and Teaching Learning Process | | | |
| 8 | Governance, InstitutionalSupport and Financial Resources | | | |

The actors in engineering education, factors that contribute to the performance, related administrative and academic activities and the initiatives are presented for Indian scenario in the following section:

Ministry of Human Resource Development, Government of India takes the lead from policy making through the stakeholders, funding, andguiding through AICTE/ UGC. The state

governments are also equally responsible in all activities. Most of technical universities, state arts and science universities approve the engineering programs through academic councils, boards of studies, senates and syndicates. Most of autonomous colleges are governed by the governing councils. The CEOs (Principals/deans/directors) are responsible for implementing various programs, courses through heads of departments. The faculty members are the people who will plan the courses based on the direction and funding. The analysis of the ongoing activities is presented below:

Actor: Ministry of Human Resource Development

Issues: National Education Policy and funding

Focus: Revision of policy on engineering education, networking with international universities, admission of foreign students, getting assistance from Inter National Agencies, entering into bilateral/ trilateral/ multilateral agreements for establishing the advanced institutes, faculty and students exchange, joint programs and research projects.

Actor: AICTE

Issues: Coordination of the development process, monitoring, funding for faculty development, encouraging interdisciplinary programs, networking with the international universities.

Actor: State Governments/ Directorates of Technical Education.

Issues: State policies with respect to institutes of excellence, consultancy centers in the state

Actor: State Technical Universities and autonomous colleges

Issues: Inter disciplinary and multidisciplinary post graduate programs, creation of centers of excellence, networking with international universities, twinning programs, joint research projects.

Actor: CEOs of the Colleges

Issues: Industry relevant and flexible inter disciplinary programs, faculty development, continuous process development in curricula and their implementation through industry collaboration.

The type of curriculum, method of implementation and planned outcome depends on the eight tiers which are described in Table.2. The institutes have to plan the industry relevant programs by satisfying the rules and regulations of the eight tiers. Hence, more strategies are required for successful planning and implementation.

***Criterion 1: Students and Students' Performance***

The students are mostly selected based on their academic achievements. State and central governments are providing many fee concessions, loans, scholarships, and travel concessions to attend seminars and industrial training. The Central government started one National Institute of Technology in every state and additional eight Indian Institutes of Technology have been established in different parts of the country.The existing autonomous colleges have already got recognition for their contribution to many post graduate programs. Hence, they are better placed than the newly

started centrally funded institutes. The achievement in the GATE examination has been recognized for entry into post graduate engineering programs with assistance. The selection of the students to PhD programs are based on the merits, creativity, and commitment for relevant research and development works.

Since they are to be trained to meet the global competition, they need professionalsupport from the college administration and the faculty. The institutes need to start student services section as a part of one of the new initiatives, if it does not exist.

Considering the need for educating the employees of many high performing industries, the employees who are willing to undergo master degrees in engineering and technology, can be admitted in the flexible programs where they can register certain courses up to nine credits and complete all the requirements in five years. Since they come from industry, their company can pay the fees without any subsidy. They can take dissertation works based on their industrial needs and senior engineers can be co-guides. This will enhance the effectiveness of the program and there will be additional return on the investment.

The success of engineering programs are measured based on the performance of the graduates in real life situation by the employers. Hence, the institutions are to plan not only quantitative improvements but also quality improvements in the curriculum and implementation in cooperation with the industries.

**Strategies for Qualitative and Quantitative Improvements**

- Plan and offer joint master and doctoral programs in cooperation with various national laboratories, R &D centers of MNCs in the industrial clusters and public sector organizations through Industry-Institute- Partnership cells.
- Facilitate the doctoral candidates to participate in the international conferences and programs.
- Create specific funding for faculty and post graduate students for meeting the gaps in project formulation, bidding and negotiation.
- Encourage faculty and research scholars to participate in the national and global competition for recognition and reward for their outstanding achievements in research
- Facilitate program credit recognition under mobility, networking and joint programs.

Most of the students are not aware of the global opportunities that are available to them (Deirdre Maegan). Additional training could be on the skills and competencies on the emerging technology through interdisciplinary and multidisciplinary programs. They need to be exposed to the current industrial programs in research and development. Departments can organize foresight activities in collaboration with industries and government (United Nations European Commission -UNECE, 2007). The institutes can develop policies for research and development projects and could involve the post graduate students and research scholars. The innovation centers could create more opportunities for participation by the post graduate students. Considering the growth of industrial clusters and research technology organizations, the universities can make active linkages.

Nickerson (1998[37]), Cropley (2001[9]) and Piirto (2004 [41]) recommend multiple idea-getting techniques, including brainstorming and divergent thinking methods and other instructional approaches to increasing creativity.

Universities can design and implement creative studies (Karlyn Adams, 2005 [29]).

Other suggested initiatives are counseling, continuous coaching, mentoring based on the academic and professional requirements, exposure to growing global needs of high performing research scientists and engineers. It is further suggested to include the learners in various projects for the industry based development works.

Students are source of creativity and the faculty members have to focus on their creative abilities, capabilities, skills and motives to improve them. Problem solving styles are consistent individual differences in the ways students prefer to plan and carry out generating and focusing activities, in order to gain clarity, produce ideas and prepare action (Isaksen Scott, AertsWouter[24] and Isaken Erick, 2009[22]).

Isaksen and Akkermans (2007) have developed 'Situation Outlook Questionnaire' (SOQ) with nine dimensions which measures organizational climate which will encourage the students. They are challenge/involvement, freedom, trust/openness, idea-time, playfulness/humor, conflict, idea support, debate, and risk taking.

RomeshWadhwani (2014) states that the strength of Indian students in software engineering ,their ability to communicate clearly in English, and their ability to address design and business problems with structural thinking is a huge advantage for success in corporate ladder. Hence, the institutes have to focus on these.

Students' performances are linked to program educational objectives which are also linked to mission of the institute. It can be assessed through:

- Measurement and evaluation of student achievements by tests and assignments
- Students exit interview and exit survey
- Alumni survey
- Feedback from the employers
- Performance in the GATE/ UPSC/Entrance examinations
- Achievements in national competitions
  The institutions have to watch on the performance and do remedial measure

***Criterion 2: Institutional Mission, Vision and Program Educational Objectives***

Institutional mission and vision will provide more direction for identifying the program educational objectives. Mission and vision are to be developed to achieve the mandate.

*Educational objectives are the means to attain the end results i.e skills and competencies.*The following initiatives could be been taken by the governing council of the autonomous institutes to assist the post graduate departments to develop appropriate curricula in collaboration with the stakeholders.(Thanikachalam.V,[63] 2005). To facilitate this, the faculty development programs are to be availed through AICTE sponsored faculty development programs , and the ongoing programs of National Institutes of Technical Teachers

Training and Research. The faculties haveto be trained in industry relevant programplanning, design, validation and improvements. Many autonomous colleges and National Institutes of Technology havealso availed the services of the consultants and developed processes to organizemany industry relevant programs.

***ProgramDesign***

The programs could be designed by considering modular approach as follows:

Basic Courses, Core Courses, Applied Courses, Advanced Courses and Electives, Learner designed practicum, Industrial Training; Industry based dissertation and entrepreneurship in relevant areas where as post graduate programs need to be focused on the advanced mathematics, statistical analysis, advances in the related courses, design using IT enabled analytical processes, interdisciplinary courses focused on the industrial advancements and dissertation centered around industry based problems. It is preferable to offer many electives so that the students could plan their future work. The students could be guided to choose the courses based on the specialized career needs.

***Identification of students' outcomes***

Program outcomes are nothing but planned students' outcome.

The following are some of the approaches for determining the planned outcomes of the programs:

* Program planning, design, validation, and improvement using reverse systems approach.

* Assessment of global skills and competency standards through advertised job descriptions.

* Through technical working group meetings with the employers and specialists.

* Through program specific industry participation.

* Through program specific research work with the participation of senior engineers from employer associations and representatives of various companies in the industrial corridors/ export processing zones/ industrial hubs/ clusters.

* Through job synthesis based on the industrial expansion and establishment of new production centers.

*Through detailed feedback from the alumni from tracer studies

* Through comparative studies on similar programs conducted by outstanding institutions and universities in various countries within and across programs and identifying specific global competencies

* Through synthesis of various feedbacks from the public, mass media and other public deliberations and prepare the students to use emerging technologies to advance and share knowledge globally

* Generating industry relevant courses, educational program objectives, contents, and case studies and validating them through a joint group of specialists from the industry, higher education and national labs.

***Process of review of the Program Educational Objectives***

The institutes and the universities could constitute the following committees:

- Curriculum Evaluation and Development Committee
- Program Needs Assessment Committee
- Program Advisory Committee

***Initiatives required for Generating Industry Relevant Engineers to meet the High Performance Needs of MNCsfor Selected Areas***

**Civil Engineering:** The growth is maximumin the construction of residential and industrial structures. Major current needs are building technologists and managers. Hence, the current program in civil engineering could be redesigned into specialized branch in Building Technology and Management (Thamilarasu and Thanikachalam, V, 2004&2005; Mathew &Thanikachalam, V, 2013 [57,33]).

**Infrastructure Development:** The country is investing enormous amount of funds in infrastructure development, and planning dedicated industrial corridors between Delhi-Mumbai, Bangalore and Mumbai, Chennai-Bangalore. Many new ports are interlinked with highways. Hence, new transportation engineering and management programs are needed.

**Mechanical Engineering:** There is fast growth of product design using IT enabled tools. Many MNCs have chosen India as their destination for design works. The current programs in mechanical engineering couldbe modified as design programs (Sivanesan.T &Thanikachalam. V,2009[ 49]).

**Electronic Engineering:** Embedded Systems Technology Program has very great potential for assisting Indian industries for design and production of various industry relevant products (Sheeba Rani and Thanikachalam,V, 2012 & 2013[47,48]).

**Innovation Policy Mechanism of the Institute**

Each institute could develop a mechanism in consultation with the faculty of the departments to meet the challenges of knowledge based growth in the region. The issues are presented as follows:

1. Planning innovations based on the industries needs
2. Readiness of the faculty to undertake sponsored projects and programs
3. Generation of new knowledge through research and development
4. Modes of diffusion ( patenting, licensing, new ventures)
5. Possible collaborating organizations

The Heads of the departments could get information through discussions with the industry representatives, journals, and possible extrapolations on the ongoing research works or on the brain storming activities with the post graduate students and research scholars. Further one can assess from the public sector organizations.

***Criterion 3: Program and Students' Outcomes***

The students' outcomes relate to their performance in the real life situation. To improve their employment, the outcomes are to be periodically evaluated and updated.

Sternberg (1997 [51]) states that the one consistent attribute among successfully creative engineers is that their explicit decision to pursue a creative path, educational programs should not only aim to enhance student creativity, but should also directly teach students about the field of creativity itself so that they gain in explicit awareness of their own

creative potential, as well as and understanding of methods of enhancement.Sternberg and Niu (2003 [52]) suggest to foster classroom environments and andragogicalapproaches conducive to intrinsic motivation. This will help students find their passion and shield them from the potentially damaging impacts of rewards, extrinsic motivators and experiences of failure. This will also help students develop passion, promotion of confidence, persistence and risk taking.

**Initiatives of various European Countries developing the human capital**

The initiatives taken by various European governments in developing human capital are presented below:

1. Belarus
   Initiatives: State program for the innovative development of the Republic of Belarus (2007-10).
   Outcome: Improvements in education and training methods, creation of state and commercial centers for training of specialists in innovation management and commercialization of the results from scientific research , introduction of new courses (Decree of the President of the Republic of Belarus, [12]).
2. Denmark
   Initiatives: Transformation of the Danish Vocational System.
   Outcome: Upgrading general qualification, publically funded firm specific training system. Vocational training has been successfully established.
3. Italy
   Initiatives: Plan for innovation, growth and employment.
   Outcomes: Increased the quality of educational programs, flexibility and personalization of study path; adoptability to changing economic circumstances and support for lifelong learning.( Presidency of the Council of Ministers, 2005, [43])
4. Slovakia
   Initiatives: Lifelong Learning and Advice Strategy, 2007[16].
   Outcome: Proposed new system of national certification procedures for formal learning and informal learning. The system consisted of flexible learning and advanced modules.
   Relies on an ongoing identification of learning target groups;stressed the needs of the national economy as well as on forecasting, planning and monitoring of the educational processes; supported by the introduction quality management systems.

It is recommended that such systems are very much required for improving Indian educational systems.

The student outcomes could be assessed based on through tracer studies.

The following initiatives have to be taken to inculcate the skills, competencies in planning, analysis, design, creativity, and commitment:

- Ability to work effectively across countries.
- Ability to transfer skills and competencies to design and high quality manufacturing.

- Awareness of major forces of global change.
- Knowledge of global development organizations and MNCs.
- Ability to communicate across cultural and linguistic boundaries.
- Personal adaptability to diverse cultures.
- Focus on the much demanded skills and competencies.

To meet the global challenges, interdisciplinary and multidisciplinary programs could be planned and the assistance of the networked institutes could be availed through agreement for joint programs.

The industries demand a deep focus on the analytic skills, creativity, assessment of end user needs, problem solving, interpersonal skills, IT enabled design, and prototype development, testing and effecting needed improvement.They also need professional skills to lead and contribute to the global knowledge. They should able to transfer to a range of professional activities (Sivanesan.T &Thanikachalam.V, 2009 [49]).

Sujit John (2014[55]) states that India has become a breeding ground for global talent. The number of Indians in the top management of leading technology companies and contributing to some great technology advances are due vigorous training and goal focus outcome.

Indian government and industries have to plan Industry-Institute- Community partnership. The institutes have to implement many focused management development programs for their faculty.

The faculty could identify specific global competencies within and across various engineering programs. They can motivate the students to use emerging technologies to advance and share knowledge globally.

***Criterion 4: Continuous Improvement in Attainment of Outcomes***

Continuous improvement in curriculum, instructional design and delivery, industrial training, and industry relevant research work are to be undertaken as follows (Sujatha.S &Thanikachalam,V,2013[53,54]):

The departments could conduct academic audit at the end of each year and identify various strategies and process. Some of them are as follows:

- Active discussion through academic council, board of studies and faculty meeting.
- Preparing memorandum of understanding (MoU) with the consortium of companies in the industrial corridor for getting training.
- Planning joint programs with various national and international institutes.
- Planning and conducting peripatetic workshops and seminars.
- Preparing partnership with leading research and development institutes.
- Networking with a overseas research universities and international development institutes
- Planning and conducting in-house faculty development programs.
- Planning and conducting regional, national and international workshops, seminars, and conferences.

- Quarterly review of performances and achievements of faculty, departments in the board of governors.
- Evaluation by the external expert committee and follow up improvement initiatives.
- Evaluation by standing committee of the members of parliament In the case of centrally funded institutes.
- Discussion in the quality circles.
- Tracking career outcomes.
- Broadening professional skills.
- Strengthening links with employers.
- Obtaining grants from the CSIR and other Ministry of Science and Technology.
- Career opportunities in think tank organizations through strategic planning.
- Planningglobal seminars with MNCs and networked universities.

**Focus on the following:**

- Preparation to conduct global research and understanding its implications.
- Research networks.
- Access to specialized equipment and expertise.
- Enhanced "cultural diplomacy".
- Commercialization of innovation through joint PGprograms.
- Global consultancy programs.

Hence, efforts are to be made in conducting research and development in the adapting very fast changes in technology like mobile devices and cloud computing.

ChidanandRajhatta (2014 [8]) states that the Indians successes in careers in global software organizations are due to hard work, initiative and a hunger for success. Hence, institutions have to recognize merit.

Gail Edmondson (Ed, 2012, [18]) states that the world-class research universities are at forefront of pioneering strategic partnerships, and are designed to run longer, invest more, look farther ahead and hone the competitiveness of companies, universities and regions. He brought out the following policies for successful implementation:

- Ensure a predictable, stable environment for funding and regulation for long-term strategic partnerships to thrive.
- Give universities the autonomy to operate effectively, and form partnerships.
- Reward activist, collaborate universities-and encourage more to be that way.
- Help universities strive for excellence.
  Hence, various organizations like CII, FICCI, and other industrial associations could emulate the global trends and plan for strategic partnership for getting creative solutions and consultancy services.

***Criterion 5:ProgramCurriculum***

Curriculum forms a key document which could be reviewed by all stakeholders and many recruitment decisions could be made around this. To develop industry relevant curricula, the following suggestions are offered **(**Thamilarasu.V &Thanikachalm.V,2005 [59]):

- Modernization of curriculum through feedback from the students, faculty, alumni and MNC employers.

- Joint evaluation by the MNC employers and faculty.
- Implementation through cooperative mode in collaboration with the industries cluster/ industrial corridors.
- Comparative study of other well developed curricula.
- Net working withother lead institutes in India and abroad for cultural contexts, research practices,and ethical values and frameworks.
- Commissioning expert team and modernizing the curriculum for interdisciplinary and multidisciplinary programs in emerging technology.
- Creating research networks.
- Getting the programs accredited.
- Constituting ad hoc Boards of Studies for interdisciplinary and multidisciplinary programs.
- Explore emerging technology programs for employees of MNCs through MOOCs.
- Improve diversity of graduate student population.

Sternberg suggests that curricula should be balanced with a focus on the synthetic, analytical and practical aspects of successful intelligence, which will result in creativity.

***Criterion 6: Faculty Contributions***

The core team will be responsible for creative development of the programs and the faculties are developing the students. Efforts could be taken to induct part-time faculty from the research and development departments of industries and national laboratories. The scheme of visiting faculty could beadded so that Indian professors from foreign universities could be welcomed during their sabbatical leave. Later they can plan faculty exchange and joint programs and projects.

**Enabling Administrative and Quality of Work Life**

Delbecq and Mills (1985[13]) suggest that faculty will be creative when they have a shared commitment to their projects and when they are given adequate resources to conduct their work.Amabile and Gryskiewicz (1989, [5]) concluded that faculty would be creative when their work is intellectually challenging. King and West (1985) concluded that they would be creative when they are given high level of autonomy and control over their work. Cummings (1966[10] and Teng and Wijinen (1999) concluded that projects/proposals that are more creative are presented to the institution's approval when CEOs are encouraging them they take risk. These findings are equally applicable to Indian situation. Hence, the faculty has to be given the following:

- Stress free environment
- Sharing the commitment
- Providing adequate resources
- High level autonomy
- Control over the work
- Encouragement to take risk

To transform the existing faculties the following suggestions are presented:

* Detailed analysis of teaching jobs, synthesis of skills and competencies needed, preparing training programs, and implementing them.

* Planning ISTE faculty development programs and implementing them.

* Planning AICTE sponsored faculty developed program and implementing them.

* Planning TEQIP sponsored program and implementing them.

* Industrial training in selected companies in the desired field.

* Advanced training in selected national labs.

* Sponsoring to overseas workshops,, seminars, and conferences.

* Sponsoring scheduled faculty development programs of IITs/NITTTRs/NITs/Academic Staff Colleges of the universities.

* Sponsoring for doctoral programs under quality improvement program of AICTE.

* Providing study leave for prosecuting the desired higher studies.

Corruption in recruitment of the faculty should be eliminated (Jacques Hallak and Muriel Poisson, 2007) otherwise star performers would not find a place in the departments.

***Criterion 7: Facilities and Technical Support; Academic Support Units and Teaching Learning Process***

The institutes have to create, construct, maintain and add needed program related facilities for implementing the programs are listed below:

* The autonomous institutes which have 25 years standing could take modernization through All India Council for technical education (AICTE).

* Can plan to improve the facilities through externally funded projects like Technical Education Quality Improvement (TEQIP) [World Bank assisted project].

* Plan to get funds through annual planning from state governments.

* Through Bank loans which could be repaid through internal revenue generation.

* Through industrial donors.

* Through lease which could be paid through consultancy projects.

* Getting additional facilities by undertaking sponsored projects from the industry and national laboratories.

***Criterion 8: Governance, Institutional support and Financial Resources***

Continuous support is to be offered through institute by the Governing Council, Ministry of Human Resource Development (MHRD), AICTE, NITTTR, University Grants Commission (UGC), and Academic Staff College wherever needed (Thanikachalam.V, 2005[61,62])Institutions are planned as autonomous actors with varying degrees of interdependence with, legislated commitments to the external stakeholders, state and central governments.( Varghese and Michaela Martin,2013 [67]; Wikipedia) The governance of higher education is largely based on the principles of democratic values and participation (John Fielden, 2008[ 28]). The educational administration should be free from the corruption. Institutes could prepare perspective plans and strategic plans for the growth of postgraduate programs. The facultyand the heads of departments will have to be provided needed financial and administrative support for undertaking the academic development, proposing new courses and programs, externally funded projects, planning seminars and conferences (Ponnuswamy.M&Thanikachalam.V,2011 [42]). The annual budget has to incorporate the needs

of graduate programs, infrastructure like building and library, dormitory, laboratories, workshops, computer facilities, software and consumables. The leadership of the institutes should play a proactive role (Thanikachalam.V,2005[64]).

**Supporting links between Research and Technology Organizations**

The postgraduate programs have to link with the needs of the industry. In this aspect many European Countries have established linkage mechanisms. A selected a few linkages are presented in the Table- 2.

Table- 2 Linkage mechanisms between R&D institutions and Industries

| S. No. | Program | Outcome |
|---|---|---|
| 1 | The Swedish Program of Joint Competence Centers [Vinnova, 2004, 68] | Swedish Research and Technological Development and Innovation System established centers for strong interdisciplinary research environments at the universities, making major contributions to postgraduate education, developing the new styles needed to build research-based relationships and university programs. |
| 2 | Poland's Network Supporting Institutions of Poland[16] | Network consisted of the polish agency for Enterprise Development, the Industrial Development Agency;Centers for Advanced Technologies, National and International contact Points. Regional Industrial Parks, Science and Technology Parks,Technology Incubators, Technology Accelerators. Centers of Technology Transfer and Centers of Excellence were established and assisted the post graduate departments of the universities. |
| 3 | Estonian Competence Centers[16] | Small R&D institutions established and operated together by a number of companies and universities. Focused on applied research to develop products. |
| 4 | Research and Technological Consortia in Sectors of National Priority of Greece | Fostered the collaboration between business and research organizations through long-term research and technological development. |
| 5 | The first Enterprise Scheme in Belgium | Hired part-time researchers to carry out research relevant for the hiring company. |
| 6 | Mega Projects Program of Russia (Science and Technology Russia, 2006) | Developed networks and supported the relations between research institutions and industry. |
| 7 | The Republican Centre for Technology Transfer in Belarus | Promoted international partnerships, trained specialists in innovation related business activity. |
| 8 | Business Partnership Program (BPP) of Moldova | Promoted research and development (R&D) partnerships between companies and teams |

| | | |
|---|---|---|
| | | of scientists to develop new commercial opportunities of economic benefits. |

The postgraduate departments in engineering could establish such linkages with the industries to strengthen the programs and researchers through Confederation of Indian Industries (CII), Federation of Indian Chambers of Commerce and Industry (FICCI) and other local associations of small scale industries.

Sternberg(1997[50,51,52]) suggests the following:

- Design educational curricula that promote all components like synthetic, analytic and practical aspects of successful intelligence
- Use of divergent thinking exercises, open –ended challenges such as those posed by problem based learning
- Promote the decision to be creative and meta-cognition of the creative
- Foster class room environments and andragogy approaches conducive to intrinsic motivation
- Re-align the high-stakes testing system to reflect the need for focus on creativity
- *Promote the integration of entrepreneurship*
- *Integrate games and play into engineering education*
- *Offer more interdisciplinary core courses*
- *Improve career counseling and opportunities for career exploration*

***Assessment of Support System***

For every program, it recommended to perform an assessment of support systems for internal quality assurance.

For every suggestion which has to fulfill the needs of the key factors taken for accreditation, one has to review the existing support, expected support from the faculty, contracted support from the collaborators and the ultimate support from the administration. This will make sure the path for implementation.

***Factor –Weakness-Suggestion-Strategy Analysis (FWSS Analysis)[64]***

For every program, it is recommended to perform Factor- Weakness-Suggestion-Strategy –Analysis. In one of the faculty development institute, the department proposed a two year program in post graduate diploma in Sustainable Development. Considering the drawbacks in planning,this program has been withdrawn and efforts are being made to revise and update.

***RashtriyaUchchatarShikshaAbhiyan (RUSA) [National Higher Education Plan]***

The Indian Cabinet Committee on Economic Affairs has approved a centrally sponsored scheme (CSS) for reforming the state higher education system in India. RUSA aims to improve access, equity and quality in the state higher education system. Under this RUSA, the autonomous engineering colleges could be provided sufficient funds for establishing industry relevant interdisciplinary and multidisciplinary post graduate programs. This approach would enhance the capability of the Indian industries and research and development centers.

The institute authorities have to support the departments in permitting them to apply for

bidding for externally funded projects, undertaking sponsored projects, conducing international seminars and conferences, offering training programs to employees of industries, permitting the faculty to accept overseas training programs which are offered by overseas universities and organizations,participating in the international conferences, and accepting short-term visits as external resource persons. There may be many opportunities for extending the support the department for undertaking various academic and professional activities. They need full support, delegation and empowerment without these there cannot be any innovation.

***Summary***

For creating high performing post graduate departments, there should be whole hearted support from the institute's administration. Then only the departments can offer industry specific interdisciplinary and multidisciplinary postgraduate programs and get global accreditation. All the eight criteria center onthe total vision and undivided commitment of all administrators, faculty and staff. The products of the post graduate programs will be confidently meeting the challenges of fast growing industries. The institutes could undertake the assessment of support systems, FWSS analysis and strategies for overcoming the internal obstacles, barriers and bottlenecks.

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