Need of Promotion of Innovation in Indian Engineering Institutes

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There has been a consistent debate on the rankings of the engineering Institutes every year, and quality of the graduates coming out of hundreds of government and private universities in different disciplines. The clamour for engineering degree is understandable in India, where the degree is considered as a major step in climbing the ladder of closely knit social fabric based on one's status. If the engineers are touted as the 'creators' of new things, unseen before but imagined in virtual world, then each of the 1.5 million engineers must be able to contribute to the growth of economy. Instead, the manufacturing Industry despairs over the poor employability of one and half million engineers a year because it finds the graduates are well not trained for the jobs that industry offers. It is also understood that the University may not be able to cater to the needs of a specific company and gives only general broad based training in a particular discipline. It shall be the responsibility of the industry then to give specific job oriented training to the new recruited engineers.

The question of poor employability of the engineering graduates may arise from a number of factors, starting from poor preparedness for the engineering profession to quality of training imparted to the students in engineering schools where teachers have no direct exposure to industrial practices, and finally the evaluation system which expects the students to learn by rote. It is not just the question of the ability or poor preparedness but they way the science is taught in pre-University years, particularly in XI and XII classes. The focus in these two years, which may even predate into the last two years of the secondary school education, is on passing examination with as high a score as possible, without understanding. There is little scope in the course structure for bringing out the innate ability of an individual to analyse the science as it is observed or apply equations of abstract mathematics in daily life. The race for the top few percentiles, to get into the 'Best' engineering Institutes, leaves behind the desire to learning anything new on your own. In these four formative years of education which are also the most impressible years of teenagers, the creativity is diminished, if not lost. It is learnt, sadly, that it is not necessary to be curious but just by mugging a few equations and stereotype answers you can sail through with flying colours. Since the number of engineering seats is more than the aspirants, the admission is almost certain if not in Government schools then in private universities, irrespective of the score that one gets in the entrance examination.

The Institute of Chemical Technology (ICT), Mumbai, conducted comprehensive diagnostic tests on all its new entrants last year, at both UG and PG levels, under the Technical Education Quality Improvement Programme (TEQIP) which is supported by Ministry of Human Resources and Development and the State Government. The tests included testing the numerical ability, language skills, creativity, visualization, self-awareness and some of standard personality tests. The analysis of close to 600 students was an eye opener. Although a sizable number could

handle manipulation of numbers, only 10% of the new entrants could score moderately well in creativity and awareness. Only one of 100 can give accurate description of 3D world around them that they daily travel through. The worst score was in language skills, with majority showing very poor reading and comprehension skills. This group of study comprised of a very small number, but knowing that these entrants came with very high scores in the entrance examination, one can extrapolate the findings to other Institutes which are poorly endowed with faculty or infrastructure. One wonders what causes such a decline in the quality of the students at the entry level. It can not be simply the lack of ability of individuals, or inadequate training imparted to them in schools and junior colleges.

The current set of examinations is not really challenging enough to identify the true potential of these engineering aspirants. Once they are in, they need to be remoulded to take up the challenges their profession throws at them. Unfortunately, the University examination system is also slowly following the same pattern as the higher secondary education. The emphasis is again on passing examinations and not on learning the professional and other skills for life. Most engineering students learn the equations as formulae when they are recited in the class and forget them once the examinations are over. There is little scope given to them to use these principles or relate them with experiences in real life.

Interestingly, we had done another analysis of the graduates, to relate their performance in final year with their scores in Physics, Chemistry and Mathematics (PCM) at XII examination, because these subjects are considered for admissions in engineering Institutes. It was difficult to spot any relation. On the other hand, the performance of these graduates showed a strong linkage with their scores in Languages and non-technical subjects in XIIth examination! It is important to know that there are no coaching classes in languages! If the students do well in languages, it means on their own they find their ways of 'learning'. Is coaching in specific subjects then killing the curiosity and 'learning' process of these youngsters?

The internet and telecommunication might have made 24x7 connectivity possible, but reading habits of the students are at negligible levels. The writing skills are also reduced to one-liners and comprehension does not go beyond one paragraph. In academic fraternity, the despair about the quality of students is as intense as that in industry about quality of the fresh graduates. If at the basic level, the situation is so alarming, what shall be the conditions of the post-graduate education and research in engineering institutes? And most importantly, can we do something about it? Merely increasing the numberof graduates and post graduates and even Ph.D.s is not enough. It may even be counterproductive if the quality is not matched to the requirements.

Research is now a regular activity at major Universities and academic Institutes in the country. MHRD is promoting research in a very big way. It is understood that all IITs put together need to churn out 10000 Ph.Ds. every year! It is said that there is direct link of number of Ph.Ds. in engineering with per capita income of the country. All TEQIP supported Institutes, in particular, and NITs also have increased their research activities significantly in the second phase of the TEQIP project which is aided by soft loan from World Bank. Most of this research, however, ends into research publications, conferences and theses. However, converting this research output into transferrable technology is hindered by lack of availability of cohesive infrastructure today in the country. Research and development is not equal to technology, unless all loose ends of the process and product are tied up. It is unlikely that such a required infrastructure shall be built adequately in near future in the country, barring a few examples of technology parks in IIT-Madras, and few centres of excellences in specific areas. In this regard, IITs are often and better

funded by MHRD because the funding is provided directly by the Central Government. The State level universities, however, suffer hugely as there is no confidence in their abilities because of little knowledge of their performance at the MHRD level. IITs, because of their brand name in the UG education, are considered more suitable by MHRD for establishing such parks even when some of the Institutes, like ICT, have made their name in equal measures, in specific areas. It is high time that MHRD takes a more objective view for supporting better performing State level Institutes for generous special funding, of course with necessary accountability on deliverables. As the Fraunhofer Institutes in Germany, India can create the Centres of Excellences, in specific areas of engineering with mandate of developing technologies based on research conducted in different organizations that can support the industries to improve local economy. Shutting down industries when they have no access to better technologies is not the solution as also leads to loss of livelihood for local people. The academic world also has to take a notice of the problems faced by such industries, in terms of the technology employed and provide affordable solutions to overcome the problems. At the same time, industries have to work with local institutes, supporting the efforts of the academia to arrive at a workable and economical solution. Also it should be understood that there is nothing like free solutions.

Innovation shall be a key parameter today in order to survive in the global competition. The funding by Science and Technology projects shows that a vast majority of the funding is spent on purchasing high end equipments worth of crores from companies abroad. If some one wishes to build a unit, he has to still provide some quotations for that. It is pity that that we do not have many manufactures of the equipments required even for routine research. It needs to be also understood that many of these equipments have originated from Universities in those countries. The academia and research fraternity in Indian industries need to work together to develop competitive technologies and products that can support Indian industries as well as society in general for their needs.

The MHRD invited ICT to participate in a meeting on 1st August 2013, to brain storm on the activities of TEQIP to improve Industry –Institute of Interaction, particularly for Innovation, along with IIT, Kanpur, IIM-Calcutta and Indian school of Business, Hyderabad, amongst other Institutes. ICT is known to have nurtured organic links with Chemical and Allied industries for long and was recognised by AICTE and CII in 2013 as the best Institute for its symbiotic interaction with the Industry in Chemical Engineering. It was decided in the meeting that ICT would propose its own model for Industry-Institute interaction for Western India. ICT conducted then a meeting on 11th September 2013 with 28 TEQIP Institutes from Western India, i.e. Maharashtra, Gujarat, Madhya Pradesh and Rajasthan, participated in the discussion. Further, on 25-27th September 2013, ICT conducted 'TEQIP Innovation Meet" which was also attended by TEQIP institutes from rest of the country.

ICT then presented the project concept to develop a Research & Technology Park in collaboration with partner Institutes and Industry in these meetings. The need of establishment of **Innovation and Technology Park** was acutely felt by all participants to convert the research done in different laboratories. However, considering the investment required for establishing such a park and longer gestation period associated with such parks elsewhere, ICT was asked to undertake Networking Model for enhancing technology development in a meeting conducted on 11th October 2013 by MHRD.

The **Innovation Networking of TEQIP Institutes in the state of Maharashtra** is a result of the meetings at MHRD and the brain storming sessions held between different Institutes. The

project was whole heartedly supported by the State of Maharashtra and the National Project Implementation Unit (NPIU), MHRD. It was envisaged that this Networking would use current expertise and infrastructure available at the partner institutes to develop/create prototypes for technology development and transfer. It was also hoped that the spirit of innovation shall be spread to other states toenthuse young engineers and technologists for entrepreneurship. ICT is a hub for the networking with other Institutes under TEQIP to promote this spirit of Innovation.

ICT took the initiative to form a virtual network of Institutes in the State which promises to bring together different engineering disciplines to build products and prototypes based on their research. Although, initially planned for Western India, the scope was reduced to the state of Maharashtra only because of funding pattern of TEQIP where the State was also expected to put in its share in the project. It is expected that this Pilot Project of Networking shall help different industries in the region to maintain competitive edge in global scenario.

Most innovations require partners from other disciplines and thus creation and operation of Innovation Networking of Indian Institutes may become imperative.ICT's close relationship to the chemical and allied industries has led, in the past, to relevant research programs with a high level of innovations, large consultancy programs, a dynamic curriculum development process and a high level of involvement from the industry. In Chemical Engineering, its contribution is well recognised by its peers and its highly motivated and qualified faculty and talented students have an outstanding history of academic achievements. ICT thus presented an ideal model to promote the Networking activities.

After a delay of few months, the final funding was approved by NPIU through TEQIP, for the Innovation Networking in Maharashtra in March 2014 but funds were received only in June 2014. Out of original 9 partners, finally 5 Institutes, Institute of Chemical Technology (ICT), Veermata Jeejabai Technological Institute (VJTI), Dr. Babasaheb Ambedkar Technological University (DBATU), Sardar Patel College of Engineering (SPCE) and Shri Guru Govind Singh Institute of Engineering and Technology (SGGSIET), signed MoU on 1st April 2014 to launchformally the Innovation Networking with 14 projects. The list of the projects is given below for reference with faculty involved in each project. The project is coordinated by the author with his colleagues in ICT.

A glance at these projects indicates that these are down to earth projects where each institute brings in its own expertise. It was not easy to convince the partner institutes to participate in the program. While discussing with different Institutes, the participation of the individuals became more important than collective vision of the group from any Institute. This has to be learnt as a lesson from this program. Most faculty that we talked to preferred to work in their own confined boundaries, fiercely protecting their interests. The hurdle seems to be the language barriers, not as English, but the language of each discipline. Each engineering branch follows its own terminology and teaching each other was a task itself. However, the final team emerged from these parleys which took place almost on weekly basis, and over set of lectures on need of innovation at various institutes. The final five Institutes accepted the spirit of Innovation in its true form and a cohesive team has built itself for execution of the project. We realised the need of at least one champion from each place to pursue the idea of innovation in collaborative manner. I guess, when others see the benefits of such cooperation, they might join the movement on their own. The participation was kept otherwise entirely voluntary.

Our second hurdle was getting project staff to work on these short term projects. The assistantship was of the order of the MTech or Ph.D. fellowship, that too only for nine months. We faced the same problem as the industries, i.e. lack of talented and motivated assistants to work on these ideas. At this time we took a conscious decision to involve the current UG students from all partner institutes. This was a risk as we were working with inexperienced bunch of youngsters, but here was the biggest surprise for all of us. The UGs were the most enthusiastic lot who just jumped on the opportunities offered to them. That is when we stared rethinking about the ability of the graduates passing out of the engineering institutes. Until now, they had very a few opportunities, if at all, to work on something on their own. These projects gave them a chance to apply to real systems,whatever they had learned so far. This experience also gave us a hope that the situation does not seem to be as bad as we thought earlier. We may have to rethink in the future the way we educate these students. We need to challenge these youngsters. If they get an opportunity to do things differently, we can change the entire mind set of the students towards their learning. The projects were quite a hit among these teams, who started learning from each other. We could witness, in each design workshop planned at different Institutes at frequent intervals, different team members asking questions, going back to drawing board each time they realised their idea has some problem or other, going through calculations and designs again and again, to meet the requirement of the projects. And they never gave up. Engineering solutions had to be found for every problem.

There were deadlines set up by me as project coordinator on each project, to complete the basic designs, to prepare a bill of materials, complete with entire set of specifications, online submissions of reports, and discussions for designs and input by each team member. Anyone from the team can bring an idea and argue over it. Each one had freedom to look for resources, build more networking and bring skills if the team was lacking in it. Many of these students learnt new techniques, and new softwares on the job, upgrading themselves continuously as they struggled to learn new areas, and other disciplines. If they had not studied the subject earlier, they learnt it from their seniors and brought themselves at par with them. For us, the experience has been satisfying, knowing that we have started a new movement among these students. The vacation will end on 30th June and we received fillers that the students who had to go for industrial learning during the vacation and could not join this activity so far, want to be part of the teams. At DBATU, they considered this training equivalent to industrial training. Additional team members will join bringing their experience on the table once the colleges reopen in the first week of July. Right from the beginning, we did not put restrictions on the students who wished to be a part of the project. Everybody has been welcome and now we have probably an army of UG students working on these projects, each member doing his/her bit. A few Ph.D. students from ICT also pitched in with their experience. We have seen the emails among the team members, exhorting each other to do more to beat the deadline.

I wonder if this approach can be adopted formally for education and to promote learning in our system, where the project building becomes an integral part of the curriculum. Case studies based teaching can build confidence of the graduates as it provides a holistic approach to engineering education. It also means a different teaching methodology which can challenge the students to do their best. The teacher will not just pass on the information to students in the lectures but facilitate the learning from each other while working on a project. It provides an avenue to interact with other disciplines and accountability as a team. We have passed through the basic design stages on paper in just five weeks where many designs were drawn, modified and thrown away but at a point, we had to freeze the designs and in this week the projects have

moved into building prototypes as per the designs. There is no 100% guarantee of success at this stage, but we will have to improve now on the job.

We faced another hurdle now. We did not purchase any readymade equipment under this scheme. The components of the system, however, could be purchased. Some of the PIs still carried notion of buying the entire equipment from outside. Others decided to build the units themselves. But buying the components, as small as resistors costing a few rupees every time team needed them, was difficult, considering stringent rules of purchase for any WB supported project. Finally, we decided to combine requirements of all projects, as mechanical, electrical, chemical and special materials. Our teams fanned out throughout the city finding the vendors who can give the materials, collecting price-lists and registered them with the TEQIP-Networking office as we had to follow the e-store system of ICT to place the orders. Te entire purchase is being coordinated at ICT for all partners who are located at remote places. The panel of the vendors was made and registered with Purchase cell for the procurement of components. The process took a month to collate all the information, selecting the vendors with value added services without additional cost. This has streamlined the purchase of all small items. Here is another lesson that we learnt, and so the student teams. Accountability of the project funds with specific requirements were identified at the beginning of the project execution. Each partner institute can send the requirement and the system can now supply it within three to four days, from approval to PO generation to purchase and payment. The project assistants appointed on the project are getting hands-on training in Project Management. The entire exercise is now turned into Human Resources Development, Project management and Inventory Management projects, apart from the Product Engineering. One of the Project Assistants shall use this experience for his Project Management internship.

We also realised how difficult it was to get standard materials for building the products. Unlike in US or Europe, where we can simply walk into a DIY store to buy every item of the shelf, we had great difficulty in indentifying the suppliers. Many of those who were identified did not want to do any thing with University fearing the paper work that they had to do. Some of the suppliers flatly refused to provide a material unless we order them in thousands. Most items are still imported and local vendors were not even aware of their availability. We have been working on a tight schedule and also on tight budget. We learned to ignore such vendors and decided to do more legwork to find better suppliers. Today, the projects have moved into fabrication stage and we hope that we will make it well before the dead line of 31st December 2014.

The success of these projects is no more with the project investigators but with the bunch of youngsters who sacrificed their entire vacation to work on the ideas. They have taken ownership of the projects as they have been promised the partnership in the project outcomes. They fiercely guard their designs, and keep working furiously to meet the deadlines set for them. They also are learning corporate working, team work, keeping the cost factor low, machine designs for easy maintenance, protecting own IPRs and respecting those of others. We see now among them healthy respect for other disciplines and appreciating the efforts that each one is putting in.

We strongly believe that this pilot project has brought a sea change in attitude of the students towards their profession. They are able to relate their theory classes with practical applications and thus are ‘learning’ better. Coordination amongst students has increased and instead of competing, they complement each other well. This probably throws up an answer to my question raised earlier, what we can do about the declining quality of graduates. The answer is probably involving them earlier in their profession, particularly to solve real problems as they progress

through their classes. It may not be possible to teach every thing in the class, but learning on job would provide a better education. And each of them may be credited for their contribution in a continuous assessment. The idea is make the learning an enjoyable experience and at the same time appreciating their efforts in learning. It is believed that such an approach would prepare graduates to meet the demands of the profession when they join the industry and industries' concern of employability of the graduates will be taken care of. There would also be the possibility of the team members, with their stake in the development, opting for entrepreneurship for manufacturing and marketing their own products. The management of the engineering Institutes may take a role in promoting the Innovation Labs with ALL support extended for supply of materials for building such prototypes by the students with clear understanding that the innovators participating in the project will have a stake in the final product's IP rights. Participation of technical and support staff, particularly in machining and fabrication, can be also welcome with appreciation in suitable form. The most important part is in identification of right type of product and process that can bring in the value addition to students' education and help local economy and society. A great care is needed to identify the innovation in each idea that the students may bring to the table. We need to engineer the engineering education to meet the demands of the country by appropriately modifying the curriculum to incorporate the innovation activity in the syllabus.

If this spirit of cooperation and collaboration catches up with other Institutes, ICT will be willing to share its experience. Ultimately, we believe that this will lead to innovations that are affordable in local communities, businesses and education.There still remains the question of role of the Government, particularly MHRD, in the process. It may not possible for a country with limited financial resources, to establish full fledged Research Parks costing billions of dollars over a short period of time, as Germany has done for its Fraunhofer Institutes in specific areas. But coordination amongst different institutes might help to work in the form of virtual networking. However, a set of Networking Innovation Park at different locations in the country, with dedicated set of people who can facilitate the growth of Innovation, still remains the need in long term to promote the Innovation using the largest resource we have, i.e. the engineering students in their third and final years.The success of this small pilot project under TEQIP can probably rekindle the proposal that ICT put forward to MHRD for establishment of Innovation Parks in four corners of the country.

TEQIP-II: Innovation Networking Project

Project Coordinator(s): Professor V. G. Gaikar & Professor A. B. Pandit. ICT, Mumbai

Sr. No	Project Title	Institute	Faculty Member(s)
P01	Micro-channel reactors for highly exothermic and high pressure and high temperature systems	Dr. BabasahebAmbedkar Technological University Institute of Chemical Technology Sardar Patel College of Engineering	Dr. M. Sadaiah Prof. V G. Gaikar Dr. C.S. Mathpati Mrs. AnupaSubnis Mrs V.P. Joshi
P02	Sensors for pesticides and biological species in water management and therapeutic materials	Institute of Chemical Technology, Dr. BabasahebAmbedkar Technological University Sardar Patel College of Engineering	Dr. Ratnesh Jain Dr. Neetu Jha Dr. P.R. Nemade Dr. M. Sadaiah Mrs. AnupaSubnis Mrs V.P. Joshi Mr. B.B. Pimple
P03	Continuous and tunable Microwave assisted Microreactor system for chemical reactions	Institute of Chemical Technology, Dr. BabasahebAmbedkar Technological University Sardar Patel College of Engineering	Prof. V G. Gaikar Dr. Neetu Jha Mr. S.Kasthurirangan Dr. M. Sadaiah Prof. N.R. Raykar
P04	Continuous and tunable Microwave reactor system for chemical manufacturing and extraction of natural products	Institute of Chemical Technology, Sardar Patel College of Engineering	Prof. V G. Gaikar Dr. Neetu Jha Mr. S.Kasthurirangan Prof. N.R. Raykar
P05	Continuous and tunable Cavitation system for chemical reactions	Institute of Chemical Technology, Dr. BabasahebAmbedkar Technological University Sardar Patel College of Engineering	Prof. A.B. Pandit Prof. V G. Gaikar Dr. M. Sadaiah Prof. N.R. Raykar
P06	Ultrasound assisted sub-liter size continuous water purifier	Institute of Chemical Technology, Dr. BabasahebAmbedkar Technological University	Prof. A.B. Pandit Prof. V G. Gaikar Dr. M. Sadaiah
P07	Lab-scale self-sustaining pyrolysis system for Polymer-to-Chemicals	Institute of Chemical Technology Sardar Patel College of Engineering	Prof. V G. Gaikar Dr. NileshRaykar Mr. D N Jadhav
P08	Mosquito-repellent textiles	Institute of Chemical	Prof. M.D. Teli

	using sustainable and eco-friendly materials	Technology, VeermataJeejabaiTechnical Institute	Dr. R.D. Kale Dr. V. D. Gotmare
P09	Laboratory scale inexpensive gas chromatograph	Institute of Chemical Technology, Sardar Patel College of Engineering	Prof. V. G. Gaikar Prof. N. Raykar
P10	Continuous Enzyme Reactor in microcapillaries with reduced pressure drop	Dr. BabasahebAmbedkar Technological University Institute of Chemical Technology	Dr. Yogesh Mahajan Dr. Naik Prof. V G Gaikar
P11	Solar energy based biomass-to-chemical conversion system	Dr. BabasahebAmbedkar Technological University Institute of Chemical Technology	Dr. Yogesh Mahajan Dr. Naik Prof. V G Gaikar Prof. A.B. Pandit Dr. V. H. Dalvi
P12	Robust Iris Recognition System	SGGS Institute of Engineering and Technology, Nanded ICT, Mumbai	Dr. Holambe Dr.NeetuJha Mr. S. Kasturirangan
P13	Polymer-Metal composite stent(s) for drug delivery in angioplasty	ICT, Mumbai Dr. BATU, Lonere	Dr. Ratnesh Jain Dr. PrajaktaDandekar Jain Dr. M. Sadaiah
P14	Design and fabrication of Improved Mobile blancher for turmeric processing with solar concentrator	SGGS Institute of Engineering and Technology, Nanded ICT, Mumbai	Dr. B.M. Dabade Dr. V.B. Tungikar, Prof. A.B. Pandit Prof. V.G. Gaikar