6. TOWARDS A CULTURE OF TEACHING-CUM-RESEARCH IN ENGINEERING COLLEGES: A CASE STUDY OF RAJARAMBAPU INSTITUTE OF TECHNOLOGY

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Abstract

Engineering has been a preferred option for students after the higher secondary level in India. As a result, the number of engineering colleges has seen a significant increase, especially in the private sector. And yet, the industries complain about a dire shortage of quality engineers. Initially, the setting up of IITs, RECs (later renamed as NITs) focussed on development of human resources in engineering and technology for our developing economy; and for sure, the Indian engineers have established their reputation in engineering and design skills. Today, we are competing globally not only in areas such as space, atomic energy, and agriculture, but also in conventional areas like automobiles, chemicals, pharmaceuticals and engineering equipment - crucial for social and economic development of the country. It is obvious that a critical issue for the future success of Indian industry is the growth of engineering education in India. This calls for development of a research culture in the engineering colleges and institutes of the country, and a policy to spread this culture effectively. It is emphasized that India's doctorate degrees are less than one per cent graduate engineering degrees. This percentage is much higher for most other developing and developed countries. Although, many engineering colleges / institutions are improving their research output, they are much below the norms attained by some of the best international institutions - more so in the case of the private colleges. There is no gainsaying the fact that the challenge for our engineering education system is to make a quick transition from primarily teaching institutions to teaching-cum-research institutions. We discuss in this paper, some of the mechanisms that would help transition in this direction, describing the efforts of Rajarambapu Institute of Technology, Islampur, as a case study.

Engineering Education in India: General Scenario

Although the Indian industry, today, is competing globally in several areas like pharmaceuticals, chemicals, software, automobiles, and industrial equipment, the emphasis during the early years of Independence was on producing qualified and competent engineers for the developing economy that was India. This was a major motivating factor in setting up the premier institutions like the Indian Institutes of Technology and the Regional Engineering Colleges. There is no gainsaying the fact that the Indian engineers have earned the reputation for their engineering and designing skills even in emerging fields like space, aerospace, and atomic energy thereby

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accelerating the social and economic growth of our country.

Of late, due to the ever-increasing need of engineers in the industrial sector and the prospects of a successful career, engineering has emerged as a preferred option for the bright students of our country at the 10+2 level resulting in a significant growth of engineering colleges - more so in the private sector. According to the data available for 2006, India produced about 2.3 lakhs engineering graduates, 20,000 engineering post-graduates; and about 1000 PhDs. It is worth noting that India's doctorate degrees are less than 1 per cent of graduate engineering degrees, while the figure in USA stands at 9 per cent, for UK 10 per cent and for Germany 8 per cent. In Korea, the figure stands at 3 per cent. Indeed, it is tragic that our engineering educational system attracts only a small percentage of best engineering students to post-graduate studies, and only a microscopic number to doctoral studies. It is of interest to note that of all the engineering graduates produced in the country, IITs and IISc contribute to less than 1 percent, but they contribute to about 20 per cent of the post-graduates and some 40 per cent of PhDs produced in engineering sciences in the country.

However, sudden growth of engineering colleges has taken its toll on the quality of engineers produced and their employability in various industries, resulting in unemployment of our engineering graduates. It is interesting to note that there are over 1,100 private engineering colleges in the country producing about 75 per cent of our engineering graduates, and yet the list of top ranking fifty colleges in the country comprises only a minuscule percentage of private colleges. We must, however, bear in mind that nearly 90 per cent of the private colleges are affiliated colleges with little or no academic autonomy.

Surely, we need several initiatives to attract our bright students to pursue a research career. This would entail faculty improvement programmes, partnerships and commitment from industries, and invigorating existing PhD programmes. In addition, we shall need to improve the research facilities which are often dismal; and help the doctoral students get suitable employment, either in academic institutions or in industries. One reason, we have shortage of research faculty, is the very small number of PhDs produced in the country. Yet another factor is the huge disparity in salary compared with industry, and performance based incentives. Government agencies like DST and CSIR, the newly formed National Science and Engineering Research Board, industry and academia need to come together and formulate policies and mechanisms that would help inculcate a teaching-cum-research culture in our engineering colleges and institutions.

R&D in Engineering Colleges / Institutions: Present Status

That the availability of good quality PhD students in an institution is the most important factor that drives R&D, needs no emphasis. And so is the availability of quality faculty. As a matter of fact, both the issues have a high degree of correlation. As remarked earlier, every year, about 1,000 engineering doctorate degrees are awarded in the country, which is less than 1 per cent of the total engineering graduate degrees awarded each year. How does this figure compare with other countries? PhD degrees awarded in most countries range between 5 to 9 per cent of the total engineering graduate degrees awarded. Thus even at 2 per cent level, we should be producing about 4,000 PhDs every year! A projection shows that by the year 2017, the target could be about 10,000 PhDs even at 2 per cent level [2]!

Out of about 1,000 engineering PhDs produced currently in the country, IITs account for nearly 400, and institutions like NITs, IISc and other engineering institutes

account for the rest. However, the share of the private colleges / institutions is minuscule. This explains why we do not have faculty that can inspire our bright students to R&D. It is important to realize that quality faculty could emerge only from quality students taking up academic jobs in engineering institutions.

R&D in Industry

In India, government's contribution to R&D is to the tune of over two-thirds, and this share has declined over time. At the same time, there has been an increase in R&D investment by business enterprises, which now stands at about 28 per cent of gross domestic expenditure on research and development, compared to just 14 per cent in 1991. In China, business enterprises account for as much as 71 per cent, while government research institutes account for only 19 per cent. For sure, the growing share of R&D performed by the private sector is a healthy trend, as private enterprises are more likely to transform the results of their research into products and processes more rapidly than the government sector[3].

India is one of the world's fastest growing economies, *vis a vis* China. True, the past few years have seen a rise in private investment in R&D. However, majority of new companies belonged to knowledge-intensive sectors. Of late, India has turned out to be the world's leading exporter of IT services. Simultaneously, aerospace exports are also growing by 74 per cent a year. Major Indian companies are investing in high-tech companies abroad, in pursuit of technology - say, Tata Steel's takeover of the British industrial giant Corus, or Bharat Forge's takeover of forging companies in Germany.

But, there are ample opportunities too! In a move to bridge the gap between industries and institutes, the AICTE has allowed companies to set up research and development centres in engineering colleges[4]. Initially, 50 colleges across India are expected to be part of the initiative. While college faculty and students would get hands-on experience, industry could get R&D done much cheaper, thereby developing a partnership with the institutions. Under the initiative, the colleges would need to provide about 2,000 sqft area for the R&D centre on their campus; and faculty and students will be involved in projects. This could prove to be a lucrative opportunity for research activities benefiting all stakeholders.

Patenting Activity in India

With opening of economy in 1993, the growth of patenting activity in India accelerated, and then at a much faster pace during 1999–2007. This is directly attributed to Indian industry's growing inventiveness and competitiveness. Industry's share in patenting grew from about 40 per cent patents in 1990-1999 to around 60 per cent patents in 2000-2007. During 1990-2007, Indian patent output was 26,250 patents wherein the patentees from industry sector contributed 57 per cent of the total patents, from University sector 5 per cent, and from the government sector 21 per cent of the total patents. Individual inventors contributed 17 per cent of the total patents during this period [5]. Undoubtedly, industry has been the lead sector in patenting activity in India. IITs, IISc, All India Institute of Medical Sciences, and the University of Delhi have been the leading participants from the University sector. From Government sector, Council of Scientific and Industrial Research is the leading patent assignee with more than 4,500 patents to its credit.

According to Indian Patent Office statistics for the year 2008-2009, the total number of applications for patents filed in India stood at 36,812, out of which 16,061 patents were granted. It is also interesting to note that out of 36,812 patent applications filed, only 6,161 patent applications were by Indian applicants. Again, among the Indian patentees, CSIR

was at the top with 696 patents.

What is our share to the patenting activity across the world? The total number of applications filed across the world in 2006 is estimated to be 1.76 million. Between 2005 and 2006, the number of filings worldwide by applicants from China, the Republic of Korea and the United States of America increased by 32.1 per cent, 6.6 per cent and 6.7 per cent, respectively. In 2006, approximately 727,000 patents were granted across the world [6].

It is thus imperative that awareness be spread about IPR and filing of patents among the academic staff of the engineering colleges / institutes of the country; and encourage them to file patents based on their R&D / innovations. This would help maintain a quest for cutting edge technology and encourage self-reliance.

Transition from Teaching to Teaching-cum-Research culture: Challenges

The discussion hitherto makes a compelling case for transition from largely teaching institutions to teaching-cum-research institutions. Quality teaching and quality research go hand in hand. Quality teaching would attract good students at undergraduate / post-graduate levels, and quality research would inspire at least some of them to take up research leading to a PhD degree. However, the reason often cited for poor research output especially in private colleges is the present administrative structure with very little financial autonomy and regulated fees. Salaries account for nearly 80 per cent of the budget, with little left for any meaningful research. True, many colleges and institutions are putting in efforts to improve their research output, but the lack of adequate financial resources and the competent and quality research faculty often prove to be the stumbling blocks. Further, very few institutions / colleges in our country have evolved into research institutions starting from the undergraduate level, and hence the challenge for our existing engineering education system is to transform from primarily teaching institutions to teaching-cum-research institutions.

Often, a majority of the faculty members in engineering colleges / institutions do not possess a PhD degree, nor do they have any exposure to research *per se*, nor are they aware of the developments and the front line research taking place in their own field. Their prime responsibility is to complete the syllabus. They are also occupied with some administrative responsibilities. This is largely true in the case of private engineering colleges / institutions that have mushroomed over the last decade all over the country. They rarely even have had an opportunity to write a research proposal; and even if they do write one, they are unaware of the funding agencies to which they can submit their proposals for support. This is a common picture, one gets to see in majority of the private colleges. Thus, we are faced with the age-old chicken and egg problem! We do not have quality faculty, or infrastructure that can attract talented students to PhD, and without talented students enrolling for PhD, we cannot hope to have quality research faculty in future either!

Engineering research necessarily implies development of new techniques / technologies that could be transferred to the industry for increased output and / or better efficiency. A research problem has to have relevance to a specific industrial application, thereby implying an industry-institution partnership. This would enrich the student's PhD experience; and even throw a challenge to his / her intellectual capabilities thereby bringing out the best in him / her. Continuous interaction and exchange of information with researchers working in the same / allied fields is equally important, for which the institutions need to provide necessary encouragement and support. It is also desirable that the

institution facilitates challenging jobs / careers after PhD. This would mean a total transformation of our engineering education system.

A huge gap exists between the industries and the engineering institutes - both at teaching and research levels, giving rise to obsolescence. No wonder a fresh graduate finds himself / herself at bay while entering an industry upon graduation. Similarly, a PhD student may not find the research carried out by him / her to be of much use to the industries; and feel frustrated. Engineering research at the engineering institutions must necessarily help improve industrial products and processes; or come up with new technologies.

RIT: A Case Study

Rajarambapu Institute of Technology (RIT) represents a typical engineering institute located at Islampur, Sangli District, in the interior of Maharashtra. It was established in 1983 with the objective of imparting state-of-the-art technical education. Over the years, RIT has flourished into one of the leading institutions in Maharashtra offering undergraduate and post-graduate courses in automobile, civil, computer science, electrical, electronics and telecommunication engineering, mechanical engineering and IT. RIT also offers doctoral programmes in civil, mechanical and electronics engineering. RIT also offers one MBA programme. Total strength of RIT stands at nearly 2,500 students as of today. Through TEQIP-I, RIT could create good infrastructure at UG level; and develop and improve its laboratories. It has been selected for TEQIP-II. Now through its own efforts, and TEQIP-II scheme of the World Bank, RIT plans to consolidate and expand its research base and transform itself into a leading teaching-cum-research institution in the coming three years or so. Incidentally, as per the CSR- GHRDC survey for the year 2010 for engineering institutes, RIT ranks 6th in Maharashtra State and 58th at national level.

The Faculty Spectrum: The faculty spectrum essentially consists of 110 faculty members. Only 8 possess a PhD, 35 ME / MTech and the rest are BE / BTech. In the last five years, 3 have been awarded PhD degree. As of today, some 24 have registered themselves for PhD. But this number includes only a few from the RIT staff, the rest being from other engineering colleges registered through RIT. Of these, about 15 are expected to complete their PhD requirements in the next 2/3 years.

An Uphill Task: If RIT were to make a transition from a primarily teaching institution to a teaching-cum-research institution, it was imperative that its faculty too made a transition from a largely teaching faculty to teaching-cum-research faculty. This is an uphill task, since most of the faculty members do not have a PhD! This is where it was thought pertinent to talk to each faculty member individually and obtain his / her views on how to go about it. It transpired that several faculty members were involved in consultancy projects with a few industries in the neighborhood, presented papers in conferences / symposia, and even earned some revenue for the institution. However, very few had publications in reputed national / international journals. Though almost all exhibited varying interest in undertaking research projects, it was the younger age-group of 25-40 years that evoked maximum enthusiasm.

Focus Group: It is important to note that it is age group 25-40 years that would primarily be responsible in building up the research ethos in the next decade or so. Hence, it is but imperative that we help them obtain a PhD, make available the necessary infrastructure and research facilities, and gradually make a transition towards a teaching-cum-research culture. This group thus needs to be treated as the immediate focus group. RIT has a sizeable number of staff members holding M.E. / M.Tech. degrees at the level of Lecturer / Assistant Professor in this age group, most of whom are keen to pursue R&D activities

leading to PhD. This strategy has a twin objective of expanding their own academic horizons, and better prospects in their own academic career. To develop a research culture, and build up a competent faculty dedicated to research, RIT has been working on plans to provide all out support to them to nurture their R&D interests and help them complete their PhD requirements. This would pave the way to establishing strong research groups at RIT in different engineering disciplines in the next three to five years.

Making a beginning: Realising the need for the faculty members to be made aware of agencies like DST/UGC etc from where support could be obtained for research proposals, the areas in which support is available, and the art of writing a research proposal in accordance with the format in which the proposal needs to be submitted to agencies like DST/AICTE/UGC, a two-day awareness-cum-training programme was organized for the faculty members from RIT and nearby engineering colleges with scientists / experts from DST. This exercise has helped in development of several research proposals at RIT. Also being contemplated is the training in making effective oral presentation of their project proposals to the Programme Advisory Committees of the agencies like DST that decides the fate of the proposals. This is a skill that needs to be developed. Interactions with scientists / engineers who have successfully completed the research projects of various agencies off and on are also being contemplated.

Rewards and incentives: Appreciating the fact that teaching and research go hand-in-hand, an academic environment needs to be created where a host of different activities reinforce the research at the institute. The staff members need to be encouraged to deliver talks on advances in their own fields / area of research. A day and time in a week could be fixed for the purpose. An incentive scheme for reward in some form - cash or kind, is being devised for faculty members whose research papers appear in reputed national / international journals.

Environment conducive for research: Research scholars may be encouraged to supervise M. Tech. projects. PG students would find a better rapport working with them rather than senior staff members. Bright UG / PG students could be associated with the research projects undertaken for PhD. Depending their contribution their names could be included as co-authors. Scientists / engineers / entrepreneurs from different fields may be invited to RIT for talks / lectures or interaction with students / faculty members. This would help them remain abreast of the advances in different fields and maintain an atmosphere conducive for research. National Science Day / National Technology Day may be observed with participation of all the students, staff members and the general public. On this occasion, the labs may be thrown open to the people and the work being carried out explained to the public. Other events like elocution competition for students, techno-fest, and quiz need to be encouraged. RIT has directed efforts in this direction[7].

Milestones yet to cross: In its pursuit for becoming a leading teaching-cum-research institution, RIT has been working on a plan to encourage all faculty members to pursue research, attracting promising research scholars to RIT, and establishing the necessary facilities and the infrastructure in its various Departments, along with initiating new courses in frontline areas of science and technology. What are described here are only the first few steps being undertaken by RIT towards developing a teaching-cum-research culture. Yet many challenges remain. Autonomy for the institute, institute-industry partnership for meaningful research, guarding against obsolescence, sponsored projects from the industry, recruiting high-calibre faculty, attracting and retaining promising bright PhD students and help them find challenging

employment, counselling for entrepreneurship; and making teaching-cum-research part of academic culture are some of the milestones RIT still needs to cross.

Conclusions

In this paper, we have attempted to assess the present scenario of engineering education in India, and made a case for developing a teaching-cum-research culture in the engineering colleges / institutes, especially the engineering colleges other than the elite institutes like IISc, IITs and NITs. We have outlined the status of engineering colleges, their constraints and limitations in making a transition from teaching alone to teaching-cum-research institutions. In particular, we have discussed the difficulties in attracting quality doctoral students and retaining them, and providing them the best opportunities to utilize their talents to the fullest. This is so because the quality doctoral students of today would make the quality research faculty of tomorrow. Industry-institute partnership would pave the way for meaningful research in crucial areas and accelerate the social and economic growth of the country, avoiding obsolescence at the same time. Initiatives taken by RIT towards developing a teaching-cum-research culture have been discussed in a case study of the institution. The various facets discussed in this paper make it amply clear that industry-institution partnership could work, but only in a limited manner. For the country as a whole, however, we need a national policy perspective for R&D in engineering sciences to be formulated through the Government-Industry-Academia initiative for developing a teaching-cum-research culture in our engineering institutions. This would be the right step towards achieving technological self-reliance and socioeconomic development of the country.

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