7. COLLEGES SHOULD DO MORE IN RESEARCH & INNOVATION TO IMPROVE QUALITY

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Research is the seed corn for the harvest of benefit. Benefits from research far outweigh the costs. Research gives joy and sense of achievement. Research provides economic security and confidence. It enhances the rate of return on investment and opens gates of opportunities. It enriches the human civilization.

Key words: innovation, creativity, commercial exploitation. Patents, industrial development.

Synopsis

The paper outlines, in brief, need and importance of conduct of research in universities and colleges in partnership with industry and delineates their role and responsibility. Research is a profit making activity and not a financial liability. Research creates joyful atmosphere in learning, and improves the quality of education as well as competitiveness of industry. Yet, why most of the colleges and industry in India are not research oriented? Why industry hesitates to sponsor research? Why colleges do not have research infrastructure? The mindset of key people, both in industry and institute, unfortunately, is not in favour. The syllabi are oriented to teaching known knowledge & a practice presuming that knowledge is finite. Truly, knowledge is infinite and students need to learn skills to discover unknown. Research & innovation is a serious shortcoming in India. Education without research & innovation, remains incomplete and irrelevant in modern sense. So the Indian institutes do not rank high in world list. Many students not satisfied, go abroad. The interaction between institutes and industry for research, is too weak, which is adversely affecting achievements of both. The paper illustrates with examples, how research in universities and colleges in UK, USA have benefitted industry. It presents the models of interaction to build synergy between the two. Research leads to industrial development and employment generation. The paper argues that the industry and institutes need to recognise full scope of innovation phenomenon and jointly contribute. Innovation capacity of India depends on educating youths in innovative skills. Next generation top professional leaders, to be globally competent, need to be educated in institutes with research base. With its vast youthful population, India can be a big source of innovation for humanity.

Introduction

Implications of global shifts on strategic planning in technical education: Universities in India are observed to be inward looking and not having adequate interaction with the world outside. They do not have connections, as much needed with their counterparts abroad. They do not have vision to help industry to win in global market. They teach irrelevant knowledge from shelf, mostly yesterday's knowledge, today, coming from abroad.

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Professors have almost no experience in industry, discovery and innovation. Very few institutes like IITs, NITs are engaged in research. So their standard is high, hence preferred. However, by world standard, they too are behind. Vast majority of the colleges do not have infrastructure and technical capability to conduct research & innovation. They are not knowledge generators but distributors. So there is no force in their teaching. They lack depth and relevance. Colleges, therefore, are mostly producing graduates as technology followers and not leaders. Graduates get employment like soldiers, at best in multinationals. But they are expected to produce captains to lead in industry on national and global planes. Primarily, it is on account of lack of research and innovation in colleges that the quality of education by global standards is poor. Global economy is undergoing significant structural changes. Is India prepared to match and go with the world? What are the long term implications on education?

A study by NASSCOM reported that only 25 % graduates are employable, the rest have to make up deficiency by attending finishing schools. There is a huge energy in youths, they are brilliant, yet too few, become technology pioneers, and technology leaders on global plane, because that is not what the present institutes are teaching students to become. The visions & missions mentioned on college broachers remain jargons. Commitment to implement them, is lacking.

The paper presents, in brief, Indian and international experience. AICTE, UGC, and Technical Education Quality Improvement Program [TEQIP] are now prescribing creation of research ambience in campuses and providing financial support. TEQIP, in association with World Bank, is putting around Rs 4000 crore in 300 well performing engineering colleges. It is well realized that research in S&T has become very important for economic health, so also, for national defence. Industry is expected to take a long range view and actively participate with colleges in research. Industry cannot achieve peak performance by being stand alone. Industrial development, today, is research driven. The paper recommends ways to build synergy between the two.

Case examples

Geographical Positioning System [GPS] was invented in Cambridge University; birth of Genetic engineering took place in Stanford University, the discovery of DNA was done in Cambridge, Inventions in electronics in Karlsruhe University, Germany. Vast number of the inventions took place in universities and colleges. Secondly, Apple Computer Company was born in MIT Boston, Microsoft was born in Harvard. 3000 new technology based firms owe their origin to MIT. Universities and colleges have now become the birth place of inventions, and hi-tech firms. Inventions inspire students to excel. Modern universities and colleges are doing not only teaching in class rooms but going beyond to research and enlarging out reach. Impact of university research on human civilization is far and wide. Can Indian universities and colleges do this? Why not? It is the need of the time that colleges and Universities in India engage in research in partnership with industry.

There is a story told of Michael Faraday. Faraday had demonstrated his discovery, of electromagnetic induction on which the dynamo depends, to Prime Minister Benjamin who asked what use it was. Faraday replied, "As much use as a new born babe". Years later, another British Prime Minister, Margaret Thatcher, admitted that Faraday's invention had generated more wealth than the entire capital represented by the London Stock Exchange. This is to say that research is financially very much rewarding than normally imagined.

Nowaday's, many innovations and competitions are taking place in Indian institutes. Recently, students and professors of JNEC College in Aurangabad have designed a racing car with new shape, aerodynamically fit.

It is awarded first prize in Channai by "Society of Auto Engineers of India". Awareness for research in youths is growing.

True that India is late starter in engineering education. It took momentum only after independence. It was presumed till then that new technology could be discovered only abroad. Our colleges were then designed to teach technology coming from foreign and not designed for indigenous research. People were happy to become followers in technology. India has been as a result constantly buying technology from foreign countries.

Research & Innovation generate surplus. They provide economic security

Experience in the world tells us that benefits from research outweigh the costs far more. The rate of return [ROR] on investments in research is around 25% to college, and 60% to public, against ROR of 15-20 % of a normal commercial project. Besides, students acquire research and innovation skills, which they use lifelong. Research provides insurance from obsolescence. It provides economic and technological security. It takes the nation ahead of others, which is so essential in competitive world. Colleges can serve the people better, if they add research in their frame work. Research does not consume resources but generates surplus. The dividends from investments in research to the college and to India are extra ordinary. Now engineering colleges have acquired proficiency in teaching. It is right time for them to switch over to research and development. At least better performing colleges should dream big, think great to become research based. It may be mentioned that American universities and colleges have high commitment for research, and so the America and its universities rank high in the world. There are around 130 research universities in US who produce most of the research output and PhDs. Best of brains from world over aspire to study and migrate to USA. Thomas Jefferson the founder president gave philosophy that, if America wants to be a leader in the world it must first succeed to lead in higher education. Bush Commission's report 1945, gave another philosophy that "*Research should be the main product of universities, and education as bye product.*" It strengthened the research in universities which made USA a forerunner.

Integrate education with research and industry

In order to become a significant economic power in this century, it is essential for India to restructure its engineering education without future loss of time and integrate the same with indigenous research. Though a large number of engineers & technicians come out of engineering colleges every year, yet the scientific and technological achievements of India bear no relation to the vast number of S & T personnel. The quality as well as relevance of education by world standards, is missing. We are distinctly a technology follower nation

It is seen that basic premise of technology changes 4 to 5 times during the service career of a teacher. A teacher cannot teach the latest developments in the field of his specialization unless he is exposed to latest developments. Engineering colleges today like their counterparts abroad are meant to provide not only competent engineers but also newer technologies to industry. **Unless a professor is involved in research, he has very little to teach**. It is seen on, one hand, that many engineers are unemployed and on the other hand, engineers with specialized skills are not available. There is a mismatch. What is wanted is not taught and what is taught is not wanted. So as to improve industrial competitiveness at this critical juncture of time, it is essential for India to integrate education with research and industry.

Industry knows, now, that it cannot do all the research it needs, by itself, even if they have R & D centres. Industries cannot be globally competitive without research output from universities and colleges. So they whole

heartedly sponsor and participate with colleges. They are aware that Industry and institutes are interdependent. They cannot remain stand alone entities. SSI and SMEs cannot afford to have R & D centres. They realise that synergy between industry and institute for the cause of research and education needs to be built for mutual gains. Research in isolation remains critically unexamined and untested, unchallenged without disputation. It is believed that private knowledge is knowledge lost. The conclusions of research must be openly discussed and debated in scientific community. Hence is the importance of research in public university. It is well realised that the power of research is demonstrated not only by the single isolated innovation but by the ability to create new technology based industries, some of them becoming the most economic power drivers.

Research & education are complimentary to each other

Research subsidises education and education subsidises research. Most important, it makes learning joyful and creative. Learners become achievement oriented. Teaching and research are found to be inseparable and mutually supportive to each other. Every professor is to be viewed as a scientist; he should be given fund for research at the time of his appointment. Professor should be encouraged to build a research team consisting of junior and senior students along with lab assistants. The culture of institution must have to change in favour of research. Their performance should be measured in terms of what new they have discovered and patented and not how much they have memorized. They should make the college a source of new knowledge, new theories, and new technologies. Regions, cities and nations develop faster where the institutions lead in knowledge and technology. No society, region or nation prospers without good research. Research earns more money, more endowments, name and fame for colleges. They attract endowments and funds for research. Thereby, they lower down the cost of education and tuition. Education then becomes qualitative and cost competitive. Bond between industry and institute becomes stronger. With advancement in technology awareness in Indian industry for research is growing.

Experience of Silicon Valley, Research Triangle Park in North Carolina, route 95 in Boston, Bengaluru etc indicate that knowledge institutions have now become key players for the regional development. They have moved from periphery to the centre of development. People's development especially in science and technology matters most. Indian colleges should therefore think strategically and start research & innovation centres in their campuses and become deserving to provide world class education in cutting edge technology to youngsters. Education with research and innovation spirit alone can move a nation forward.

Systems Matter

Theory of education says, if there is no significant research in colleges then there is no significant quality in education. **Quality of education does not grow where research is absent**. Research and education are like two ends of a bow. The arrow does not move forward unless the two ends of the bow are tightly tied together by a string. Neither end has a force without the support of other. An institution binds the two ends together, namely education and research to provide quality education. What we notice in universities abroad is that there are many research companies located on the periphery of colleges. They draw ideas from research conducted by professors and students in college. Students work in these companies on research projects. Company researchers teach in colleges. There is give and take between the two. Quality of both research and education goes up, and the cost to a nation is optimum. What they experience is that peak performance in industry cannot be reached without the support from institutes and vice-versa.

The conventional wisdom in technical education, of only teaching orientation, which once served well, is no more fit for today and tomorrow. The time demands revolutionary changes to promote quality through technological research, innovation and entrepreneurship. Institutes must act fast to reform otherwise foreign universities are likely to get hold and dominate Indian education market. Indian professors have contributed immensely in universities in USA. Why they are not able to contribute in India? Our systems and procedures are obstructing their performance. Our universities have rigid inflexible, outdated rules and regulations; we need to adopt well proven systems & procedures from developed countries. Some colleges are planning to be in top 20 in world list. Many have the potential, but they ought to use proper policies and practices, systems and procedures. It is not a matter of just putting more money or appointing more men on the job. It is more a matter of using current and appropriate systems in research and innovation

Colleges with centres of excellence provide superior education

Western schools now believe that colleges without centres of excellence on campus for technological research and innovation, entrepreneurship development, patent & IPR, technology transfer, venture capital, Hi-Tech start ups, spin-off of technologies and spin-off of New Technology Based Firms are incomplete, irrelevant, and nonviable in modern sense. If India dreams to be a developed nation in near future, the present technical education system needs to be strengthened in respect of above stated centres. They have to be integrated in college and enabled to provide "Technology Push" matching with "Market Pull".

They have to redesign their systems to generate new knowledge and new technology ahead of others. The present departmental store approach of distributing knowledge generated elsewhere in the world is unfit for the purpose. *They will have to install systems as "Well Springs" of new knowledge.*

Institutions have to set up such centres afresh in their campuses, essentially in partnership with alumni, and industry. Restructuring in the context of global changes has to be the main item on national agenda, without which the intellectual resource will continue to be wasted and opportunities missed. AICTE and UGC will have to do benchmarking with the systems in counterpart institutions in the developed world and make gap analysis. This is urgent because our institutions follow only that which these apex bodies prescribe.

Shortage of research & innovation skills is a major barrier in employment generation.

The key factor behind unemployment is insufficient research & insufficient innovation. Shortage of people with innovation skills is a major barrier in professional development. Universities and colleges have a major influence on India's capacity for innovation. Colleges, therefore, should have to resort to these new strategies to induct research and innovation skills in economy. They will have to adopt corporate development as a vision and mission. They should provide new technology and new ideas to industry to keep them competitive in world market. They are like heart to our body which continuously pumps new fresh blood to keep the body alive. Indian higher education must recognize the full scope of research and innovation phenomenon. They can produce captains and leaders of world class standard and enable Indian industry win in the world only, if, the above mentioned strategies are adopted.

Research & Innovation are Indispensable

Ideas are the real capital. Ideas are needed to succeed. Idea generated is opportunity generated. Research & Innovation are known sources of idea generation. Knowledge memorised in brains is important, but more

important is the ability to discover new knowledge, new theory and evolve brand new idea. Colleges are the legitimate places to create idea people. It is their prime function. They have no reason to exist if they do not do so. The importance of research & innovation for future of children and grand children needs to be realised in right perspective, and infrastructure created in colleges. This will avoid the shortage of people with innovation and enterprising skills, which is found to be a major barrier to growth and prosperity.

Most of the students today learn in a passive way. Students learn quietly what is handed over to them. They are not guided to take active hand in creation of new technologies. What did the famous philosopher Socrates teach his students? He taught them to ask pertinent questions. He ignited their minds for change. The competency of people is measured today in terms of their ability to innovate. People are needed who look ahead of time and prepare for incoming opportunities. Large youthful population is the competitive advantage of India. We ought to enable them to be innovative for meeting global needs, as prescribed by Socrates philosophy.

Commercial exploitation of research findings is our weakness. Can we make it a strength?

Invention when exploited commercially is known as innovation. Research conducted in colleges for UG, PG, and PhD often results in publication. This is good, but, better it is, if exploited commercially. Unfortunately theses remain on shelf in library. No conscious effort is made to obtain economic value from them, mainly because vision and commitment in this direction is lacking. Students, today, do not get opportunity to learn to convert inventions in to usable goods and services. Quality of research improves when it results in commercial use. To this extent, skill set of students remain deficient, in spite of potential. This reduces utility of research done and reduces the rate of return on investment. *What use is of research which has potential of exploitation but not exploited.* Wealth of a nation is vested today in doctoral research done by scholars. Japan produces 28 PhDs per million population, USA 30, and India only 0.45. Technical Education Quality Improvement program in its document [2011] have estimated the shortage of M Tech and PhD in thousands. Our universities and colleges must take a special drive in this direction.

It is a good sign that technical education in India is expanding. But acquisition of skills for commercial exploitation which is the demand of time, is lacking. Non availability of finance for innovation is the major barrier in commercialization of new technology. National Knowledge Commission report [2006-7], to make India competitive has prescribed conduct of research, innovation and creativity in colleges. It said multifaceted units like Research Park, innovation centre, incubation centre, patent centre, entrepreneurship centre, and venture capital should become the integral parts of colleges. They constitute the infrastructure for research and innovation. It is found to create much desired enterprising culture enabling students to acquire research and innovation skills. Colleges then become like magnets to attract brains from everywhere and anywhere. This makes the community to think to tap the world market. Unfortunately this wave of creativity is yet to reach the Indian shores. Innovation in Indian education is conspicuously absent. Students do not get perspectives. This is a serious lacuna. It can be rectified only by research orientation to education in colleges. Research and innovation policy if adopted by colleges they will acquire innovative character, enhance their name and increase their yearly income. When shall we realize this?

Surveys conducted elsewhere in the world indicate that New Technology Based Firms [NTBF] started by young students with origin in colleges with focus on research are more successful than those started without association with colleges. Colleges provide a powerful engine to launch the NTBF and

thereby generate income and employment. How many First Mover Entrepreneurs we have produced? Education policies and practices have to come out of old ruts. They are less productive, less efficient and outdated. You need new ideas to win in new world. Change is most wanted to replace worn out ideas. The college resources should not be frittered away on worn out paths but should be used creatively. Colleges are in general hostile to change. They have inertia. They tend to maintain status quo. We must become outward looking; centripetal in outlook, and change our mindset to accelerate reformation process, without which we will not be able to go with the world.

Research and Innovation generate jobs of high quality and income

Those nations which introduce research and innovation are found to win jobs in competition with those who lag. Can Indian professors teach innovation skills by international standards? Can they teach skills of discovery and skills to generate new technologies equal to their counterparts? How long we keep on teaching sun set technologies? We essentially need a swimming pool to learn swimming, meaning thereby we need research infrastructure to be innovative.

Why do thousands of students every year go abroad? They have been going from Gandhi Nehru period. How many more years they will have to go? **Unless and until we install research and innovation culture in India, we remain behind the time, and out flow of talent will continue.**

Colleges abroad are innovative in character, ours are conservative. They teach sunrise technologies we teach sun set. They produce leaders we produce followers, they lead a change, we follow change, they are engines of growth we remain bogies. They are not afraid of change we are. Foreign institutes live today as if future has arrived. We live in the past. The challenge today, is to create knowledge based society. It is that society which uses not only new knowledge but generates on continuing basis. Adoption of new vision of research and innovation is a must to create knowledge based society.

Experience in Foreign Countries

MIT Boston is a private research university. It obtains around one hundred patents every year. In addition, it gives birth to 30 – 40 new technology firms. A study conducted on impact of MIT indicates that around 4000 companies owe their origin to MIT. It has become a cradle of entrepreneurs. 20 % of the yearly budget of the institute is met out of sale of patents. The institute has created employment of high income for millions. Australian and Chinese universities are also ahead in this respect. Where are we? Many institutes in India have included research and innovation in their visions & missions. But they are just jargons. Only a few like IIT Mumbai, IIT Kharagpur have just made a beginning in turning out companies and obtaining patents. Indian colleges ought to attach more value for research and provide funds. Hi- Tech campus companies, on the periphery of institutes in backward areas must be envisioned. All Universities in USA, taken together obtain around 1000 patents. Indian Universities earn less than 100.

Research based Technopreneurs of Silicon Valley

The birth and perpetual success of Silicon Valley is attributed to Technical Entrepreneurs, who draw continuous support, inspiration and technological ideas from research conducted in universities. Silicon Valley has progressed remarkably well not because they are wealthy entrepreneurs but because they are technopreneurs. They have been deriving technological power from first class research and innovation conducted by professors and students in universities. Silicon Valley has provided access to professor's research output in industry. Industry is now more technology driven. A new phenomenon is observed that new industrial complexes in the world are

flocking around knowledge and technology centres. Patents, Intellectual property have become more important assets along with land, buildings, money etc. What drives industrial development is the research and innovation. Resources in research, innovation and education are the most important growth stimulating instruments today. Technical universities in Germany, 84 of them, since 1984 have patent and technology transfer offices. This has increased the outreach of the universities. Steinbeis centre is yet another scheme to take new technology rapidly to industry. European Union has designed and implemented the scheme of technology relay centre in member countries.

Prof Terman of Stanford University in 1950 gave the philosophy that, "Industry to be globally competitive, needs access to first class research in Universities; so also, first class research in universities need access to industry for its commercial exploitation". This led to the creation of Silicon Valley. The model is being used all over the world.

I remember a story of people from two different nations. In two different halls plates were kept full with variety of sweets and other attractive preparations. A common condition was put on citizens of both of the nations that they can eat as much as they like but without folding hands at elbows. People of one nation in one hall tried hard to eat but could not take the spoons to mouth. They went home without eating. People of other nation were wiser. They could eat the food bellyful. How? They ate by feeding each other without folding hands at elbows. They had no difficulty, what so ever. They went home fully satisfied. Industry and institutes should have to feed each other.

Conclusion

The paper has illustrated with examples how Japan by integrating research with education and industry has moved the nation forward. How research universities and professors in USA have created technopreneurs in Silicon Valley, how Germany has maintained its leadership by research, patenting and technology transfer. India to be competitive globally must have to integrate research with education and industry. Education charged with spirit of discovery and innovation alone can move India forward.

Colleges have a major influence on improving innovation potential of India. They are reckoned as mother of innovation. If colleges do not create centres of research and innovation then there is no hope and other way for India to be a developed nation.

A new enterprising society in the world is coming in to being. Colleges are called upon to produce not simple graduates but graduates to lead and take active hand in creating the knowledge society fit for tomorrow.

The government should appoint a commission for innovation at centre and state levels to give a boost to research & innovation, and explore its full potential.

Where once nations measured their strength by armies and arsenals, in the world of future knowledge institutes matter most. Institutes of higher learning ought to teach to invent and find unknown.

How long industry can be run on borrowed technology? Education policy should facilitate professors, researchers, to transform themselves in to entrepreneurs, equipping them to set up and run their own high tech enterprises. This is what universities in USA have done to create Silicon Valley.

Quality of education can be transformed to world class standard only by introducing research in colleges. Colleges will then become "Light House" for industry. Productivity of various professions and vocations will rise. Common man will stand to gain. Indian economy will become more competitive.

On the whole impact of research on individuals and on society is huge. Human

civilization is advancing on the basis of research in colleges and universities. It is here that they are discussed, debated and openly tested by opposing groups.

India's future is too important to be left in the hands of government alone, for it is too apathetic, nonresponsive and insensitive to people's needs. It needs genius of India citizens to meet them. Private industry should have to come forward and join hands with academics. The task is too big for government alone.

Innovation & creativity is today's guru Mantra.

If, India does not create research based universities and colleges, if industry does not associate with colleges in this mission, the colleges will be providing mediocre graduates far too low by international standards to run its national and international affairs.

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