INDUSTRY-ACADEMIA LINKAGES IN R&D AND INNOVATION

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Summary:

This paper examines several models of industry-academia linkages that exist worldwide. The different cultures, scope of activities and the benefits accruing to the two partners are discussed. Some guiding principles for achieving success are described. So also are some best practices. The major differences between University R&D and industry R&D are highlighted. The efforts of AICTE, INAE, CII, IITs and IIT Madras to promote industry-academia collaboration in R&D and innovation are discussed in detail. The TIFAC – CORES, which are the flagship project of Mission REACH, and the Collaborative Doctoral Projects Scheme of the EU are described.

Introduction

The traditional outputs of industry are products, patents and services, while those of the academia are manpower and research publications [1]. Through collaboration, however, they can together generate new opportunities, such as new enterprises, industries and innovations. Traditionally the university is involved in the early stage (or basic) research, while industry is involved in the late stage (development) motivated by technology and cost demands of real-world application. Some of the felt demands from the two partners in the emerging milieu of speed as a determinant of success are: more rapid and flexible response by the academia to industry needs; more practical outputs from the academia in terms of IP and start-ups; more effective knowledge acquisition from the academia by industry; and joint business development.

Taxonomy of Knowledge Transfer between Industry and the Academia:

Hermans and Castiaux [2] have characterized the knowledge diffusion that occurs from academia to industry in a one-way relationship, through publications and conferences, as *Untargeted Knowledge Transfer.* On the other hand, the knowledge transfer that occurs between the academia and private partners through collaborative research, consultancy or licensing is characterized as *Targeted Knowledge Transfer.*

Responsible Partnering

The European Union Responsible Partnering Handbook sets out "a voluntary programme of responsible partnering aimed at improving strategic collaboration and knowledge exchange between companies and publicly-funded research organizations (referred to as PROs), including Universities, Research and Technology Organizations and other public and semi-public bodies which engage in R&D." "Responsible Partnering reflects the belief, which is widely substantiated, that well-managed collaboration between public and private sector bodies benefits everyone".

Two principles are fundamental to Responsible Partnering:

1. Maximum beneficial use of public research
2. Responsible use of public research

It is strongly recommended that the implementation process should reflect *SMART* principles: involve steps that are *Specific, Measurable, Attainable, Realistic* and *Timely.*

The marriage between industry and academic institutions

The two are such eligible partners; why hasn't the marriage taken place?

For a marriage to take place, there are certain pre-requisites / pre-conditions, such as:

- Mutual attraction
- Mutual understanding and respect
- Marriage broker
- Promise of long-term relationship
- Value addition
- Feel-good Factor

All of these apply equally well to Industry-Institute Interaction.

Research and innovation are complementary:

Research is the transformation of money to knowledge, while *Innovation* is the transformation of knowledge to money. Or as Mashelkar points out, research is the route to Saraswathi through Lakshmi, while Innovation is the route to Lakshmi through Saraswathi. The consequences are**: "**Research is a necessary but not a sufficient condition for innovation; economic value is only created by successful innovations; business strategy drives R&D strategy".

The principal differences between University R&D and Industry R&D

Table I shows the major differences between University R&D and Industry R&D.

The Global Innovation Index - 2012 INSEAD Study

There are several parameters determining the Global Innovation Index; one of them is *University - Industry Collaboration.* According to the average answer to the survey question: To what extent do business and universities collaborate on research and development (R&D) in your country? 1 = do not collaborate at all; 7 = collaborate extensively, the results are:

Rank I Switzerland 79.61
Rank II UK 79.21
Rank III USA 78.51
Rank 22 Hong Kong (China) 62.27
Rank 28 China 58.82
Rank 47 India 46.97

Guiding principles for University-Industry endeavors [6]

This report describes the following guiding principles:

Institutional missions define the scope of potential collaborations.

Guiding Principle # 1: Successful university-industry collaboration should support the mission of each partner. Any effort in conflict with the mission of either partner will ultimately fail.

A long-term relationship is the desired end state.

Guiding Principle # 2: Institutional practices and national resources should focus on fostering appropriate long-term partnerships between universities and industry.

Establish a framework that encourages long-term university/industry collaborations.

Guiding Principle #3: Universities and industry should focus on the benefits to each party that will result from collaborations by streamlining negotiations to ensure timely conduct of the research and the development of the research findings.

Working together, creating knowledge

[The University-industry research collaboration initiative; BUSINESS–HIGHER EDUCATION FORUM]

This report brings out the nature of *Barriers to University-Corporate Research*

*Collaborations: "*Corporations and universities are not natural partners. Their cultures and their missions differ. Companies' underlying goals—and the prime responsibilities of top management—are to make a profit and build value for shareholders by serving customers. Universities' traditional missions are to develop new knowledge and educate the next generation".

Best practices for universities

It is pointed out that "the success of university research collaborations with industry sponsors depends above all on the interest and enthusiasm that faculty scientists bring to the joint research effort. But university administrations can promote collaborations by motivating their faculties to take part and by creating a customer-friendly environment for would-be corporate partners". Furthermore, "Communication is perhaps the most critical management issue in collaboration".

Best Practices for Industry

"Industry support for collaborations with universities has to start at the top—with a company's top executives. Research collaboration must meet business objectives, be specified in financial terms and ultimately be accountable to the firm's stockholders. For this reason, the company—not the university researcher—will often select research priorities".

Measuring Success

At the University of Massachusetts, the performance of the Office of Strategic Technology Alliances is "measured in several ways. One is revenue generated from industry, but others are the level of university-industry partnerships, the initiation of new faculty projects and whether a company is visible on campus beyond recruiting efforts".

Externally Funded Postdocs and Internship Opportunities @ HP Labs - Lueny Morell

It is pointed out that "innovation and invention represent the livelihood of companies in a flat world". "Universities are usually the preferred institution for post-doctoral candidates (postdocs) to spend 2 to 3 years, further expanding their research interests, experience and networks before formally initiating their careers with a company, university, or self-owned business". It is indicated that industry research labs can also provide ways to engage not only faculty and students but also postdocs in innovation and in the transfer of state-of-the-art research results and emerging technology areas into new businesses. In corporate labs future science and technology leaders can experience real-life R&D and entrepreneurial experiences that turn inventions into products and services. Hewlett Packard Laboratories (HP Labs) have been providing research experiences to postdocs, MS/PhD students and recently graduated engineers who are funded by government agencies.

Best practices for industry-university collaboration [11]

Julio A Perutze et al distinguish between the university and business perspectives of research project *outcome*: for the university it is "a result that creates an opportunity for a company, such as guidance for the direction of technology development"; while from a business standpoint, "what matters is not outcome, but *impact,* how the new knowledge derived from collaboration with a university can contribute to a company's performance".

The authors discern an "outcome-impact gap in industry-university collaborations; promising outcomes of university projects often fail to translate into tangible impacts for industry". Seven best practices are proposed to bridge this gap:

1. Define the project's strategic context as part of the selection process.
2. Select boundary-spanning project managers with key attributes.
3. Share with university team the vision of how the collaboration can help the company.
4. Invest in long-term relationships.
5. Establish strong communication linkages.
6. Build broad awareness of the project within the company.
7. Support the work internally both during the contract and after, until the research can be exploited."

AICTE efforts to promote industry-institution linkages and R&D

AICTE Research, Institutional & Faculty Development Bureau (RIFD Bureau)

AICTE has been promoting R&D in technical institutions through several schemes coordinated by the RID Bureau:

1. *Research Promotion Scheme (RPS):* Promotes research in identified thrust areas of research in technical education including technology for the physically challenged, disaster management etc.
2. *Nationally Coordinated Project (NCP)*: Promotes integrated R & D on themes of national / social significance, involving networking/collaboration amongst several institutions and industry / user organizations.
3. *National facilities in engineering & technology with industrial collaboration (NAFETIC)*: Aims at establishment of national facilities in frontier areas

of engineering and technology in collaboration with industry for design, instrumentation, testing, manufacturing, etc.

4. *Modernization & Removal Of Obsolescence In Technical Education (MODROBS*)**:** Aims at equipping technical institutions with modern infrastructural / laboratory / workshop / computing facilities to enhance their teaching, training and research capabilities
5. *Industry Institute Partnership Cell (IIPC*)**:** Provides for setting up of an IIP cell in a technical institution as the focal point for better interaction between the academia and industry.

Research Park Initiative

AICTE has decided to fund institutes, with Rs.1 crore each, to set up research parks under its own initiative, in order to encourage research activities among students."An industry partner will also be tasked with setting up the research park, along with providing funds to the tune of Rs.1 crore. The research activities to be carried out in the park will also include studies needed for the industry. "This will be a perfect give and take deal. While the industry will participate in financial assistance, the institutes will conduct research on the basis of the industry needs. Researchers will also get hands-on experience with real-time industry research activities," According to S.S. Mantha, Chairman, AICTE, the research park will be set up on the institute premises itself, which should make available at least 3,000-square feet area for the purpose.

Centres for Academic Research

The All India Council for Technical Education (AICTE) is formulating an ambitious programme to set up centres for academic research in some of the top technical institutions in the country, in partnership with corporate houses and industries.

To implement the programme, the AICTE will identify 50 "top" technical institutions in the country. A methodology and parameters to identify those 50 institutes are being worked out. AICTE will also "look for partnership with corporate houses and industries for setting up research centres which will provide a suitable environment and opportunity to both scholars and students to undertake research projects in the field of their choice". "Funds towards setting up of such centres will be shared by the AICTE and its industry partner under a ratio which is being worked out,"

Recent AICTE initiative to promote research among faculty and students through Incubation Centres

The aim of this initiative is to encourage research among students and faculty. "Institutes which are at least 20 years old will be considered. Also, institutes which have been conducting post-graduate programmes and have a reasonably good faculty will be considered for the scheme." AICTE will initiate the dialogue between corporates and interested institutions that can spare 2,500-3,000 sq ft of space to set up the incubation centres.

INAE efforts to promote industry-institution linkages and R&D

AICTE-INAE Distinguished Visiting Professorship Scheme

The Indian National Academy of Engineering (INAE) launched a Distinguished Visiting Professorship (DVP) Scheme jointly with AICTE in 1999. "The scheme envisages promotion of industry-institute interaction by facilitating the dissemination of knowledge through the expertise of experienced and knowledgeable persons from industry to integrate their rich industrial experience with technical education". The scheme has received very enthusiastic response from industry and engineering research institutions over the years. Thirteen industry experts were selected during the year 2000; eighteen each in 2001 and 2002; fourteen in 2003; ten in 2004;

thirteen in 2005; fourteen during the year 2006, fifteen during 2007; eleven during 2008; eighteen during the year 2009, nine during the year 2010 and seven during the year 2011 by a high- level selection committee of experts from academia, industry and representatives from AICTE and CII.

INAE-AICTE Distinguished Industry Professor Scheme

Based on the success of Distinguished Visiting Professorship (DVP) scheme, a new scheme – "INAE–AICTE Distinguished Industry Professor Scheme" has been launched during 2007, in the reverse direction wherein "faculty from engineering institutions, who are Fellows of INAE, will interact with the engineers in industry and get acquainted with the latest technologies and use theoretical knowledge for solving 'real life' problems encountered in industry". Under this scheme, faculty from engineering institutions will spend some time in industry to contribute to the industry as well as gain exposure to the industrial environment/requirements. The Royal Academy of Engineering, UK has also a similar scheme called "Industrial Secondment Scheme" which has proven to be a success.

INAE Distinguished Professors / Technologists

"The objective of INAE Distinguished Professors/Technologists scheme is to utilize the expertise of INAE Fellows after superannuation primarily for research in institutions/universities/research & development establishments and industry in India.

CII efforts to promote industry-institution linkages and R&D

CII – IITs Collaboration

The first meeting of CII with the IITs was held on March 3, 2010 in Delhi, at which a CII-IIT Council was formed with the aim to help India become a global hub of excellence in technical education and R&D through industry-academia

collaborations. CII and the IITs will launch an *Industry Technology and Innovation Mission* with several activities whose success will be measured by:

- Number of products developed and commercialized.
- Number of IPs generated.
- Amount of business done on the products commercialized.
- Number of well-qualified human resource experts who work on successful projects.
- IITs' position in global ranking going up.
- Industry's investment in global ranking going up.

CII – IIT Madras Interaction

As a result of CII – IIT Madras deliberations in 1987, the following initiatives were introduced:

- Industrial Associateship Programme.
- Introduction of a 1-credit course, to acquaint students with challenges and success stories of Indian industry.
- Training capsules for graduate trainees.
- Sponsorship of industry personnel for M.Tech.
- Clearing house for interactive activities.
- Part-time courses for industry professionals.
- Proposals for setting up an Industrial Research Foundation at IIT-M.
- Help from CII in M.S. (Entrepreneurship) Programme

AICTE – CII Survey on Industry – Institute Linkages in Engineering Education

An industry-institute survey initiated by the AICTE, in collaboration with the CII, aims to showcase the best practices in AICTE-approved institutes in the

branches of chemical, civil, electrical and mechanical engineering, electronics and communication and computer science and information technology (the two taken together).

The survey is an attempt to map best practices being followed by institutions and industry, to recognize them and to create a benchmark of quality education in the country; 250 institutions have registered for the online survey. The survey is part of the University-Industry Congress initiative to stimulate industry-academia collaborations, both towards achieving excellence in higher education and benefiting industry by producing quality human resource and research outputs.

"A national publication featuring the profiles of overall top 50 engineering institutions, stream-wise top five engineering institutions and top three faculties and the top engineering institution in each State, mapped on the parameters of their industry linkages, will be brought out based on the outcome of the survey". The compendium will also carry the profiles of companies who are leaders in industry-institute linkages. The CII will promote this publication in India and overseas for promoting the top institutions for increased industry linkages.

Normative ranking will be conducted against seven parameters of industry linkages in institutes including: governance; curriculum; faculty; infrastructure; services; entrepreneurship and innovation, and placements.

IITM Research Park

The IIT Madras Research Park endeavors to enable companies with a research focus to set up a base in the Park and leverage the expertise of IIT Madras. It is modeled on the lines of successful research parks such as Stanford, MIT and Harvard. These technology parks have been known to add value and impetus to

industry and business enterprises. The macro guiding principles behind the park are:

- Creating a collaborative environment between industry and academia through joint research projects and consulting assignments.
- Creating a self-sustaining and technologically fertile environment.
- Encouraging and enabling R & D activities that are aligned to potential needs of the industry.
- Providing world class infrastructure for R & D activities.
- Enabling development of high quality personnel and motivating professional growth for researchers in the companies through part time Masters and PhD programmes.

IIT Madras Research Park believes that the coming together of the Corporate R & D, the faculty and students of IIT Madras will increase the probability of successful innovation. This is the *Golden Triad* and the essential elements of this Triad are:

R&D personnel: bring in rich insights of the industry and market.

Faculty: Encompassing a wealth of knowledge from multiple domains and departments.

Students: Who work relentlessly, oblivious to the risk of failure.

The Research Park is co-located with IIT Madras and therefore brings these three essential elements together.

TIFAC – COREs

Mission REACH -- (Relevance and Excellence in ACHieving new heights in educational institutions) launched by TIFAC on October 4, 2000 (Making Industry-Academia Interaction happen) "aimed to create a constellation of world-class **COREs - C**entres **O**f **R**elevance & **E**xcellence **-** in diverse disciplines across the length and breadth of the country. Mission REACH intends to create 80-100 such

COREs, which together will emerge as a network of mini- IITs across the country, integrally connected physically and electronically through a mix of landline and V-SAT networking. Mandated to turn out top quality human resource in the area of targeted excellence, which shall be intensely relevant to the Indian industries & society, these CORES will have a flair of mini IITs".

Collaborative doctoral projects of the EU

The study "Collaborative Doctoral Education: University-Industry Partnerships for Enhancing Knowledge Exchange" involved 33 universities, 31 companies, and 18 other stakeholder organizations from 20 different countries across Europe. It highlights that both universities and business consider collaborative doctoral programmes as important channels for supporting both innovation and recruitment.

The "DOC-CAREERS" project "places a timely focus on the development and characteristics of collaborative doctoral programmes established between universities and industry, whether government, university or industry-led". "Such collaborative doctoral programmes are seen as working models of the "knowledge triangle", whereby education, research and innovation are brought together in a common framework of high skills and knowledge development by university and industry partners".

"These are doctoral theses carried out with interaction between a university, a company and a doctoral candidate. A distinctive characteristic is that industry experts take part in the supervisory committee, officially or informally. Industry can play several roles, but being in the supervisory committee is what effectively reflects the specific nature of the collaborative doctoral project".

In general, "it seems that long-term university - business collaboration schemes usually have a better chance to succeed than short-term initiatives. One reason is that universities can better deliver in the long term. Another is that long-term

collaborations tend to reflect a mature relationship, which has been well-managed on both sides".

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Table I

COMPARISON OF UNIVERSITY AND INDUSTRY R & D

University R&D	Industry R&D

Essentially long-term	Essentially short-term
Carried out by graduate students under the guidance of faculty supervisors, with the objective of fulfilling degree requirements.	Carried out by professional personnel with the objective of satisfying customer needs.
Maintaining continuity is more difficult	Continuity is maintained in proportion to the industry goals
Output is more in terms of research papers	Output is more in terms of products and processes, and patents
Scope is more deep and detailed	Scope of solution is determined by the extent of need

Appendix I

List of TIFAC-COREs

Name of Institution	**Place**	**Area**
Amrita Institute Of Technology	Coimbatore	Cyber Security
Amrita Vishwa Vidyapeetham	Kollam	Biomedical Technology
Aravind Eye Hospital And PG Institute Of Opthalmology	Madurai	Diabetic Retinopathy
Arulmigu Kalasalingam College Of Engineering	Srivilliputtur	Network Engineering
B R Nahata College Of Pharmacy	Mandsaur	Green Pharmacy
Delhi College Of Engineering	New Delhi	Fiber Optics And Optical Communications
Dibrugarh University	Dibrugarh	Clastic Petroleum Reservoir Engineering
Hindustan College Of Engineering	Padur	Aircraft Maintenance
Jabalpur Engineering College	Jabalpur	High Voltage And Power Systems Engineering

Jawaharlal Nehru Medical College	Wardha	Interventional Radiology
Jawaharlal Nehru Technological University	Kukatpally	Environmental Geomatics
JSS College Of Pharmacy	Ootacamund	Herbal Drugs
Kumaraguru College Of Technology	Coimbatore	Textile Technology And Machinery
Manipal Academy Of Higher Education	Manipal	Pharmacogenomics
Mepco Schlenk Engineering College	Sivakasi	Industrial Safety
MS Ramaiah School Of Advanced Studies	Bangalore	Digital Image Processing
MS University Baroda	Vadodara	New Drug Delivery Systems
National Institute Of Industrial Engineering	Mumbai	Ergonomics And Human Factors Engineering
National Institute Of Technology	Hamirpur	Power Transformer Diagnostics
National Institute Of Technology , Karnataka	Surathkal	Industrial Biotechnology
PSG College Of Technology	Coimbatore	Product Design And Optimization And Collaborative Product Commerce
Rajalakshmi Engineering College	Chennai	Machine Vision
Sarvajanik College Of Engineering And Technology	Surat	Environmental Engineering
Shanmugha Arts, Science, Technology And Research Academy (SASTRA)	Thanjavur	Advanced Computing And Information Processing

Techno India	Kolkata	Food Processing Quality Control
Textile Engineering Institute	Kolhapur	Technical Textile
Thapar Institute Of Engineering And Technology	Patiala	Agro And Industrial Biotechnology
Thiagarajar Engineering College	Madurai	Wireless Technologies
V R Siddartha Engineering College	Vijayawada	Telematics
Velammal Engineering College	Chennai	Pervasive Computing Technologies
Vellore Institute Of Technology	Vellore	Automotive Electronics