

## **“Knowledge Network in Action” – new paradigms from India**

by Deepak Bhatnagar, Advisor, TIFAC,  
Department of Science & Technology, India  
[deepak@nic.in](mailto:deepak@nic.in), [deepaktifac@yahoo.co.in](mailto:deepaktifac@yahoo.co.in)

*After one of the talks delivered by Dr. A.P.J. Abdul Kalam, a ten-year-old girl came up to him for his autograph. ‘What is your ambition’, he asked her’. I want to live in a developed India,’ she replied without hesitation. This paper is dedicated to her and the millions of Indians who share her aspiration<sup>1</sup>.*

### 1.0 INTRODUCTION:

1.1 Knowledge networks are increasingly taking on a ubiquitous role in transforming the way we live and work, perhaps – even how people think and act. The advent of world wide web has further catalyzed the role of Knowledge Networking – from a mere conclave of a few scientists & experts to global sharing of knowledge amongst vastly different segments of society. The emergence of open source learning and tools like Google, Wikipedia and a host of social networking websites bear testimony to the way knowledge networks are having a profound effect on our lives. A big challenge is how to create ‘*Institutions*’ for this new era, which could evolve mechanisms to pool in the expertise of seemingly different stakeholders to convert new knowledge into value-added products and services.

Although, the burgeoning economic growth of India has led to multiple actions by several agencies to create institutional mechanisms through knowledge networks, this paper would only present the efforts made by the ‘Technology Information, Forecasting & Assessment Council (TIFAC)’ in providing these linkages for transforming new ideas to products and services. TIFAC was set up around two decades back (1988) as an independent ‘*Think-Tank*’ under the Ministry of Science & Technology, Government of India. Some of the ‘*Knowledge Networking*’ mechanisms introduced by TIFAC in extending the role of Government as a facilitator between two broad sections of society, namely: Academia & Researchers on the one hand and Industry on the other are discussed in subsequent sections.

Note: The programmes implemented by TIFAC through Knowledge Networks are elaborated in sections that follow. For the complete list of projects, reports & achievements, please visit TIFAC website: [www.tifac.org.in](http://www.tifac.org.in).

### 2.0 TIFAC – A UNIQUE TECHNOLOGY DRIVEN INSTITUTION<sup>2</sup>:

Keeping in view the critical need for keeping a ‘*Technology Watch*’ on trends relevant to the needs of India, which would eventually shape actions by Government at policy level as well as research and academic institutions to set forth R&D priorities, TIFAC was conceptualized as a ‘*Knowledge Networking Institution*’. The initial mandate and the objectives of TIFAC encompass a wide range of activities, which could be summarized as below:

Generation of Technology Forecasting (TF) and Technology Assessment Reports with short, medium and long-term perspectives.

Matching actions to emerging opportunities and establishing a Technology Information Network : helping various Departments to carry out TF/TA studies, etc.

To create mechanisms to carry forward successful R&D projects from a chain of laboratories in India, both from the public and private sector, towards development of prototypes or pilot scale demonstration units. This role of ‘*Technology Intermediation*’ taken up by TIFAC has proved to be an effective instrument of change by ‘*making things happen*’. The mandate of TIFAC in a nutshell was to stimulate future technology orientation actions.

Even though, TIFAC is a registered society under the Ministry of Science & Technology, it enjoys a fair degree of autonomy in implementation of its activities and is not bogged down by bureaucratic, Government procedures. The broad directions are given by the Governing Council of TIFAC, which has eminent experts from Industry, Research and Academia as well as a few senior Government officials, including the Secretary (Head) of

Department of Science & Technology. TIFAC has indeed been greatly privileged by having outstanding people of International repute to head its Council.

The first Chairman was Dr. V. Krishnamurthy, an eminent Industrialist, who has been the CEO of leading public sector companies like SAIL, BHEL and Maruti. He was followed by Dr. A.P.J. Abdul Kalam, who after two terms with TIFAC became the President of India. The present Chairman is Dr. R. Chidambaram, an eminent Nuclear Scientist, who is also the Principal Scientific Advisor to the Government of India.

The organizational structure of TIFAC gave it adequate flexibility of operation so that it could act as an adaptive system responding to the needs of Industries, Institutions and emerging new opportunities. TIFAC itself comprises of a core professional staff drawn from Industries as well as fresh young Graduates - the average age of TIFAC scientists being around 35-40 years.

## 2.2 Technology Intermediation<sup>3</sup> *- a key role in knowledge sharing*

Knowledge is no longer a prerogative of any one country and there has to be continual sharing between countries, firms, institutions and individuals. Policy makers would be making a grave mistake if they think that knowledge creation is restricted to only a few areas like IT and biotechnology, as knowledge creation is taking place in all sectors like steel, construction, municipal management or manufacturing.

TIFAC is an important institution in India which is successfully performing technology intermediation tasks. It points out to a fact that technology intermediation is not merely a transient phenomenon which is required in countries like India which do not have a well-developed industry-institution linkage because of several years of autarkic economic, industrial and S&T policies. The specific nature and conduct of technology intermediation could however vary between countries because of their levels of economics and business development and the levels of technological sophistication achieved by the firms. Otherwise, technology intermediation is an important function in a world where knowledge is being created rapidly in many parts and global competition is growing in intensity. Networks require a network manager and rapidly growing networks require dynamic and adaptive systems of network management.

## 2.3 Knowledge and Human Network

A general crucial requirement for technology intermediation is to create a knowledge network including important stakeholders. It is much more than merely providing information on databases or providing information services. It is the building of confidence and trust among different stakeholders who have different outlooks, viewpoints and '*lingoes*'. The creation of such human networks with a focus on knowledge and wealth creation, is a must in order to sustain networks. Stakeholders interact more when they see benefits. But till they see the benefits, it is initially, necessary to maintain links through several processes as stakeholders have different '*mindsets*': meetings for TF and TA studies help people see different viewpoints; focused mission and project evaluation committees and later, the monitoring committees once the projects approved provide another facet of the human networks.

## 2.4 Technology Linked Business Opportunity Reports:

During its initial years, TIFAC short-listed a few selected areas, which were directly relevant for the well-being of the people of India in the coming decades. This was done by having a series of brainstorming sessions by inviting a large number of stakeholders from different sections of Society, both young and old. Some of these areas were low cost housing, steel & other performance materials, technologies for Sugar, Fly Ash, Composites, etc. The focus was to assess the technology status in each area, both in India and developed world, thereby identifying technology gaps and suggesting priority areas of research. The crowning glory of TIFAC reports came through a series of 17 documents, generally referred to as '*Technology Vision : 2020*', which aimed to provide a roadmap of major sectors ranging from food & agriculture to advanced sensors and strategic industries like space, atomic energy and defense. Around 300 such reports have been prepared, which are perhaps the '*raison d etre*' for setting up TIFAC, but they also helped in taking actions later towards creation of Missions.

### 3.0 TIFAC - A FACILITATOR IN THE INNOVATION CHAIN

*'Planning in a man's mind is deep water, but a man of understanding will draw it out'*. – Bible, Old Testament, Proverbs, 20:5.

3.1 The hiatus between an *'Innovator'* and *'Investor'* is well-known all around the world – it is often said that these are two different species! TIFAC has evolved a mechanism to fructify the fruits of successful research projects - mostly from public funded laboratories around the country. Linkages have been established to facilitate the Innovator – right from evaluating his technology to hand-holding him for developing it into commercially viable products, including soft financial support in the form of Technology Development Assistance. A unique feature of TIFAC projects is to set up a Monitoring Committee mechanism, drawing upon the expertise of experienced academicians as well as industry persons who take up the role of a *'Mentor'*.

It is heartening to see that the mechanisms introduced by TIFAC for nurturing innovation have stood the test of time : in fact, our interventions help bringing in enthusiasm amongst innovators amidst the global financial crisis. This is mainly because the Government has taken the role of a *'Good Samaritan'* by bringing together stakeholders into a kind of knowledge network for bringing in new products and services which are making a positive impact on the lives of the people of India.

In the wake of significant changes on the financial scenario across the world, a new programme is on the anvil at TIFAC for setting up a kind of *'revolving fund'* drawing on the expertise of banks, for financial evaluation and funding.

### 3.2 Home Grown Technology (HGT) Programme<sup>2</sup>

The TIFAC reports (mentioned in 2.2) enabled the process of understanding specific technological areas important for firms to master. Also, there was a large number of successful R&D projects in the chain of public funded as well as private R&D labs across the country. Since most of these *'home-grown'* technologies (developed in Indian laboratories) were very relevant to our needs, it was considered imperative to find mechanisms to upscale them to a prototype or demonstration scale to make them ready for commercialization. The HGT programme allowed both Industries and research institutions to upscale technologies and bring them to a point where the firms can market their products and services. The HGT programme helps Industrial firms (which were mostly small & medium enterprises) cover part of their financial risks through soft loans which could be paid back in installments spread over five years after the successful completion of upscaling the project.

As mentioned earlier, in addition to providing financial support, the evaluation process before sanctioning the project helps to bring together researchers and Industry persons with the aim of synergizing their efforts. A unique, *'hand-holding mechanism'* was developed by way of providing experts from Industry as well as Academia to not only oversee the project but also offer expert advice. There have been a number of institutions when monitoring groups have made mid-course corrections to projects. This programme never put a condition on a firm to choose a particular institution or technical person for help when required. Overall approach is to make the firm to take the lead role in R&D/technology management, to allow market forces and the actual performance of specialist to win with firm – not through diktats of linkages.

### 3.3 Critical Analysis of the HGT Programme

HGT programme continued in TIFAC from 1992 to 2005 in which 77 projects were supported with a total outlay of US\$25 million, out of which TIFAC share was US\$10 million and the rest from Industries. This score card for HGT programme was fairly encouraging with 60 projects successfully completed. 77% projects resulted in commercially deployable technology out of which 46% have actually been commercialized. It is indeed encouraging to note that these projects which have been successfully commercialized have paid back around US\$5 million to TIFAC, which was used to finance other programmes in TIFAC.

Even though, a fairly large number of projects resulted in commercially deployable technologies, very few reached the market through product and services which could benefit society in a significant way. Analysis of the programme reveals the following shortcomings:

- ⇒ lack of funds for large working capital requirements and market development
- ⇒ inadequate scale of operation
- ⇒ poor assessment of technology operations (initially)
- ⇒ lack of technically skilled manpower
- ⇒ technology shifts which led to low market prospective.

#### 4.0 TECHNOPRENEUR PROMOTION PROGRAMME (TePP):

In order to encourage grass-root innovation amongst the vast majority of people of India, including home-makers and un-educated people (who have bright ideas), Ministry of Science & Technology introduced a mechanism to promote independent innovators to become technology based entrepreneurs (technopreneurs). TePP programme aims to tap the vast potential of innovative citizens of India. During the past 10 years, more than 250 projects have been supported. The range of innovators include semi-literary farmers to Scientists/Engineers on the other hand. The prototypes developed also ranged from simple devices like a coconut breaker to a sophisticated hydrogen generator. The financial support for TePP projects includes scientific consultancy, fabrication of prototypes, patent support, product development and networking with research laboratories.

Under this programme, an initial grant upto US\$1600 is given for converting an idea into a laboratory model. A further grant upto US\$30,000 is given to develop the actual working model/process demonstration. The innovator has to contribute just 10% of the project fund so that he could become an active stakeholder and the rest is given by the Government. In view of the limited success of TePP projects due to the modest financial support, the Government has recently decided to give a supplementary TePP assistance upto US\$15,000 to refine technology for improving its marketability. In order to upscale successful TePP projects towards pre-commercial stage and to take it further to a seamless scale, financial support upto US\$100,000 of the total project cost has recently been introduced (with minimum of 50% funding coming from technopreneur).

The biggest challenge of TePP project is in scaling-up, both increasing the volume and extending the reach. An analysis of the 250 projects funded reveals that most TePP projects have remained in the form of concept and limited number of prototypes. This is because innovators are either unable or unwilling (or both) to take them further. Substantial work is often needed in most cases towards product development to suit the needs of the market.

To some extent, some of the shortcomings of HGT & TePP have been taken care of in a new programme called TREMAP, which has recently been launched and described in the next section.

#### 5.0 TECHNOLOGY REFINEMENT AND MARKETING PROGRAMME (TREMAP)

*..... taking innovations to the market*

Even though, India has a huge reservoir of innovators having original ideas and technologies, but seldom have these attained the maturity level to reach the market. This is mainly due to the fact that a good innovator is not necessarily a good businessman. Bringing new technologies to the commercial world requires integration of engineering skills, business acumen, *'a feel for the market'* and capabilities of entrepreneurship – a rare combination! Towards bridging these gaps, TIFAC has launched the TREMAP programme in 2009 with an objective to drive the innovative products, prototypes upward to reach the market through a network of technology commercialization & facilitating agencies. The programme would develop a package for each technology to attract customers and may consist of logistic support regarding market survey, preparing detailed project report (DPR), business plan, arrange financial resources, regulatory compliances, etc. The TREMAP will only address those innovations where at least the prototype model is already developed and innovators are not interested in taking it further.

#### 6.0 MISSION MODE APPROACH:

*'Ah, but a man's reach should exceed his grasp-or what's a heaven for?'*  
– Robert Browning

While implementing technology development programmes, TIFAC has experimented with varied project management methodologies. These were taken up in mission oriented projects on areas relevant to Indian Industry and society like Sugar, Flyash and Composites. It may be noted that the *'Knowledge'* generated in the form of R&D gaps

through TIFAC reports earlier were taken as a starting point for these mission mode projects. Each Mission had a nation-wide thrust on bringing together a chain of R&D laboratories, industries and academic institutions to work on a wide array of problems which were identified in each sector. Thus, breaking the mission into a large number of focused projects with definite deliverables, timelines and financial contribution, both from TIFAC and industry. The following three models were experimented in the Missions:

- ⇒ Model-I : Laboratory based Technology Development
- ⇒ Model-II : Lab oriented Technology Development with Extraneous Industry Involvement
- ⇒ Model-III : Industry Centric Innovation

During the course of implemented of these missions, it was felt that Model-III was most successful. A snapshot picture of the implementation of 3 Mission mode programmes reveals a good score-card:

#### 6.1 Sugar Technology Mission (STM):

India is the second largest producer of sugar in the world (after Brazil) but the modern method of sugar extraction came to India in 1903. Presently, there are around 500 sugar mills having varying levels of relatively old technology. The Mission used two tracks for its demonstrative exercise:

- (a) System upgradation of existing sugar mills in order to improve efficiencies of extraction and energy efficiency. The role of STM is that of a system engineer and that of Sugar Development Fund (SDF) operated by Ministry of Food, is to provide special loans for such projects. STM prepared technology upgradation schemes in 45 Sugar Mills, out of which demonstration of modernization took place in 30 mills. A total of US\$120 million was spent equally by Industry & Government for upgradation.
- (b) Experiment at the plant scale level, relatively new technologies to improve specific parameters. This track is to introduce innovative processes or new technologies. Around 10 new technologies were introduced which were aimed at improved productivity & quality of sugar.

#### 6.2 Fly Ash Mission (FAM):

TF/TA studies carried out in 1992 by TIFAC revealed that India's annual use of Fly Ash was well under 3% of the total annual production of around 50 million tonnes of fly-ash generated as 'wastes' from coal fired thermal power stations. FAM experimented with use of fly ash by inducting technologies in road/embankment construction, cement & concrete, brick making, non-wood building components and even as a soil conditioner. After eight years of sustained efforts by FAM, the annual use of fly ash has gone up to 50% of the annual fly ash production of 130 million tonnes.

TIFAC contributed US\$2.5 million for this mission but other Ministries (like: environment, power, urban development, etc.) also pitched in with support through their experts, labs and financial support. Later, the mission activities were merged into a fly ash utilization programme, which has spawned several initiatives by groups of experts.

Multiplier effects are accelerating as many technologies, procedures and standards have been stabilized and accepted by a large number of users. A good network has been set in place and growing.

#### 6.3 Advanced Composites Mission (ACM):

While India is good at aerospace applications, it is far below the worlds standards in use of composites in the commercial and civilian sectors where their use is very poor.

ACM worked closely with Industry & other user agencies by networking, developing and demonstrating products so that composites have gradually replaced Steel, Cast Iron and other traditional materials for a wide range of applications in Railways, Oil & Gas pipelines, blades for co-axial fans, road tankers (specially for transporting acids & chemicals) , house boat for tourists and biomedical devices.

A total of 45 projects were taken up under ACM with a budget of US\$10 million, out of which, around 60% was given by TIFAC as soft loan and the balance put in by Industry. It is heartening to note that around 32 projects have been commercialized and are being used.

A major 'spin-off' is the development of specialized machinery for fabrication of composites, often for the first time in the country. (e.g. 6 axis CNC filament winding system for fabrication of cylindrical, oval items).

TIFAC is also exploring tie-ups with other countries where composites is used in civilian applications e.g. through the UK's National Composites Network (NCN)<sup>6</sup>. Of special interest to India is the use of composites in the construction sector and recommendations like:

- Standards for quality assurance and design, with codes of practice
- Durability of joints & connections
- Composites working in harmony with other materials
- R&D on durability, life cycle analysis, re-cycling of composites and any environmental issues

The composites mission would welcome linking with knowledge networks in other countries.

#### 7.0 MISSION REACH – Towards 'Relevance' in Higher Technical Education:

*'The foundation of a clever country is its education system'*

– Robert James Lee Hawke (former Australia's PM).

7.1 As a follow-up of Technology Vision 2020, TIFAC had initiated Mission REACH (Relevance & Excellence in ACHieving new heights in educational institutions) to establish aptly titled TIFAC-COREs (Centres of Relevance & Excellence) in diverse disciplines in different educational institutions throughout the country. Launched on October 4, 2000, the Mission aims to bring about an architectural change in higher education system by synergizing course content, opportunities and investments to evolve world-class institutions in the form of COREs. The involvement of user industry all through right from inception ensures that 'relevance' is not lost sight of while 'excellence' is being targeted at these COREs. The main objectives of Mission REACH are

- Development of human resource of international standards
- Imparting high quality education in chosen areas of high relevance to industry and society
- Creation of sustainable linkages between academia and industry
- Upgradation of select Engineering, Science and technical Institutions relevant to industry as Centres of Excellence

#### 7.2 Setting up a Centre:

The process of establishing a CORE picks up with forging of triangular relationship between TIFAC (representing Government), educational institution and Industry/user organization(s) to serve as its foundation. The Mission targets creating a chain of such Centres throughout the country in multiple areas of Science and Technology. Through this Mission, TIFAC hopes to reduce substantially the gap between the 'top-of-the-pyramid' institutions (like IITs) and the beneficiary institutions in areas in which these COREs are targeting excellence. While the implementation period of projects under which these COREs are being created would be 3-5 years, the Centres so created would continue in the respective institutions and operate in a self-sustaining manner beyond this period.

#### 7.3 Role of Stakeholder

Mission REACH is implemented through a unique 'public-private participation' (PPP) model with each stakeholder namely: Academic institution (where the centre is located), partnering Industries (who co-finance) and the Government (representing TIFAC) work together to create a 'win-win' situation, which could be explained by the following table which gives the expected inputs and possible gains for the three stakeholders in CORE:

Involvement of stakeholders and expected benefits to them, in a TIFAC-CORE<sup>5</sup> :

Stakeholder	Institution	Industry	Government
Inputs	<ul style="list-style-type: none"> <li>• Civil infrastructure</li> <li>• Running expenditure</li> <li>• Faculty</li> <li>• Academic experience</li> <li>• Support staff</li> </ul>	<ul style="list-style-type: none"> <li>• Equipments or funds for equipment</li> <li>• Vital inputs to academic programs</li> <li>• Industry problems to work on</li> <li>• Visiting faculty</li> </ul>	<ul style="list-style-type: none"> <li>• Funds for equipment</li> <li>• oversight mechanism</li> <li>• domain experts</li> <li>• visibility at national level</li> <li>• platform to industry and academia to network &amp; interact</li> </ul>
Gains	<ul style="list-style-type: none"> <li>• state-of-the-art infrastructure</li> <li>• industry partners</li> <li>• linkages with other industry</li> <li>• visibility at national level</li> <li>• experience of engaging industries</li> <li>• live industry problems</li> </ul>	<ul style="list-style-type: none"> <li>• industry ready employees</li> <li>• training facilities</li> <li>• academic perspective to its problems</li> <li>• testing &amp; analytical facilities (especially for Small &amp; Medium Scale enterprises-SMEs)</li> </ul>	<ul style="list-style-type: none"> <li>• accessibility to advanced infrastructure in smaller cities</li> <li>• increased employment prospects for youth</li> <li>• empowering SMEs</li> </ul>

As per the design, civil infrastructure is to be provided by institution; Recurring expenditure (running/non-planned) is borne by institution and Industry; Non-recurring expenditure (capital/planned) is borne by industry & TIFAC (government). While day-to-day implementation of the project (under which a CORE has been established) is the responsibility of institution, an oversight mechanism to monitor the progress and take care of the interests of stakeholders was entrusted in the hands of a REACH Monitoring Committee. This committee, constituted for each CORE by TIFAC has 3 acclaimed domain experts each from Industry, Academia and R&D institutions.

#### 7.4 Technology Enhanced Learning

Considering the immense size as well as the diversity in the Indian educational system, it is imperative to develop mechanisms by which technology could be used to spread education to a larger section of students. The immense problem of inadequate faculty, both in terms of number and quality which could be motivated enough to teach in the 1500 plus engineering colleges spread across the India, including those, which are in remote parts of the country. Mission REACH has made a modest attempt in experimenting with two modes:

- (a) Synchronous method of teaching (through EDUSAT - Educational Satellite) : the Indian Space Research Organization (ISRO) has teamed up with TIFAC and AMRITA University to set up an e-Learning Content System (Digital e-learning Studio) and Distance e-learning classrooms at 42 engineering colleges spread across the country at which 'live' lectures could be delivered as well as interactive discussions taken place. This was a follow-up of a historic agreement in August, 2005 when the Prime Minister of India visited USA and 12 US Universities and 3 major IT companies agreed to send eminent Professors for teaching at these Centers in India. This experimental project has a long way to reach its true potential but a beginning has been made.
- (b) Asynchronous teaching : In order to develop course material of high quality, Mission REACH has introduced a programme called 'e-OUTREACH' aimed to create high quality digital content to be released in Open Source for the benefit of students, teachers and IT professionals in the country. Special workshops in IT and non-IT areas for teachers & students have been conducted, which have generated open source contents of over 150 hrs for distribution at cost. Such contents can be bought by any institution at cost, loaded onto a local server, and freely made accessible to students and teachers through their Institutional LAN. 'Creation and distribution of Open Source content' is being done by Kanwal Rekhi School of Information Technology (KReSIT) of the IIT Bombay, Mumbai. (<http://ekalavya.it.iitb.ac.in/eOutreachHome.do>), Website of e-OUTREACH).

## 7.5 Impact of Mission REACH

During the last eight years of running Mission REACH, in which 31 Centers of Relevance & Excellence (COREs) have been set up, around 120 Industry partners have taken full advantage of the state-of-the-art infrastructure and testing facilities available at these Centers, through training programmes, consultancy projects as well as research work relevant to Industrial needs. A tremendous 'spin-off' is in the form of students as well as faculty getting exposure to 'live problems' of Indian Industry. The impact of Mission REACH to the Academic community and the Industry is summarized in the Table below:

### **Impact of Mission REACH Assessment of TIFAC-COREs in terms of certain parameters:**

<b>Assessment Criteria</b>	<b>Total Number</b>
TIFAC-COREs already functional	31
Industry partners	120
Number of PG courses offered	33
New Specialization (PG courses) – for the first time in India	20
Students passed out so far from TIFAC-COREs	1500 (approx)
No. Of Faculty involved in COREs	130
Papers published in National Journals	350
Papers published in International Journals	300
Conference/Symposium/Workshops organized	150
CEP/Short term training/courses organized	250
Patents	25
Industry sponsored projects	150
Number of industries interacted with (consultancy, etc.)	400
Revenue generated (excluding student fees)	Rs.US\$ 2.5 Million (approx)

#### Broad Budgetary Details:

Total budget of all the projects under Mission REACH	: US\$50 Million
Contribution by TIFAC	: US\$19 Million
Contribution from Industries	: US\$16 Million
Contribution from Institutions	: US\$15 Million

## 8.0 THE WAY FORWARD:

We have noted a few examples of success stories in Industry-Institution linkages and have briefly surveyed a few programmes implemented by TIFAC. It is also noted that there is a strong desire to work jointly; this itself is an essential condition. Many industry associations have started making technology events as a part of major functions or exhibitions. Such interaction would need to be strengthened. There is nothing better to break down hiatus and develop linkages than continuing interaction. Fund crunch from Government sources have also helped the laboratories to look out for new sources; thus enables linkages.

While a small part of funding by Government should be devoted to open ended basic research, there is an urgent need to concentrate much of the government funding in areas which show a promise of clear end uses; this will create demonstrations of linkages which will lead to large scale multiplier efforts. If such policies are pursued assiduously and tenaciously for a decade from now, there are very good chances that Indian industries would become technologically and commercially strong in global terms in about a decade. It is around that period, Indian industries and business houses by themselves would take several initiatives to fund innovative R&D without necessarily waiting for Government support. Business houses also have to invest on R&D with an eye on future products.

9.0 CONCLUSION:  
- *Cross country research on knowledge networks*

TIFAC is now recognized by many stakeholders in industry, institutions and Government departments as a reality of Knowledge Network in action.

On the whole, it is clear that the TIFAC type of networking is essential for stimulating innovation in technology development institutions (TDIs) in India, as the transition from a protected economic regime has to deal with earlier institutional weaknesses. This network should also involve knowledge oriented and technology – business linked forecasting and assessment studies to be effective. Knowledge network should be used to create demonstrable success stories. Part government financial support for innovative projects as done by the Missions and HGT programe is also essential to incentivise the TDIs to take risks with which they are not familiar in concept as well as in project management.

Selective Government intervention and support especially to develop internal strengths in technology management may be required through a complete business cycle, say about a decade, in many traditional and mature industrial sectors in India. Once they have gone through a full cycle, it is likely that they would have internalized all aspects of managing foresight, assessment and actions for being competitive. Experience from the TIFAC case studies reveals that successes tend to replicate faster after the first success in a project or a product. Further researches into the mechanisms for such transitions and the support policy frameworks would be useful for many other countries as well.

ACKNOWLEDGEMENT:

The author would like express sincere thanks to Mr. Y.S Rajan, the first Executive Director of TIFAC, who initiated most of the Knowledge Network Programmes mentioned in this paper and has graciously agreed to share the experiences drawn from his books.

Grateful thanks to all the peers and young scientists of TIFAC, who have shared their experiences and information of implementing the programmes.

REFERENCES:

1. Kalam A.P.J. and Rajan Y.S., 'India : 2020 – A Vision for the New Millennium', published by Viking Penguin Books (1998)
2. Rajan Y.S., 2001, 'Empowering Indians – with Economic, Business and Technology Strengths for the Twenty-first Century', Har-Anand publications Pvt. Ltd., New Delhi, India (2001)
3. Siddharthan N.S. and Rajan Y.S., 'Global Business, Technology and Knowledge Sharing' – Lessons for Developing Country Enterprises, Macmillan India (2002)
4. Rajan Y.S., 'Technology Road Mapping and Indian Experiences in Stimulating Actions' - third International Conference on Technology Policy and Innovation held at Austin, Texas, USA (1999)
5. Saxena Neeraj and Ushadevi K., 'Experiences of a Triple Helix based Center of Relevance & Excellence (CORE) established in India' – paper presented at the 7<sup>th</sup> Triple Helix International Scientific Conference, Glasgow, U.K. (June, 2009)
6. David Tolfree and Alan Smith, 'Roadmapping Emergent Technologies – Planning the Future' published by Matador (2009)