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FOUNDATION FOR INNOVATION AND TECHNOLOGY TRANSFER (FITT): A CASE STUDY ON INDUSTRY–ACADEMIA INTERFACE IN INDIA

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ABSTRACT

The Industry-Academia (I-A) research linkages are considered to be the backbone of technological innovations. In developed nations, there is a strong handshake of Research and Development (R&D) programmes of universities and industries and has led to the most impactful technological innovations of the world. However, in developing nations including India, I-A interactions have not been given due credit. In 2014, though India published over 100,000 research papers and was globally ranked 9th, it fared poorly in converting academic research into patents and transfer of technologies. It was not even ranked in the top 50 nations. The major drawback of transforming academic knowledge into commercial products is due to lack of requisite expertise/centres in the universities. However, a few Higher Education Institutes (HEI) having strong and effective I-A centres are at par with many universities of developed countries in terms of promoting entrepreneurship, start-ups, patents and technology transfers. To bring academia and industry closer to each other, India needs to set up these I-A centres in large numbers in the universities. In this paper, we present the results of a case study carried out on one of the successful I-A interface existing in India i.e. Foundation of Innovation and Technology Transfer (FITT) located in Indian Institute of Technology, Delhi (IIT-D), a premier Higher Education Institute of India. FITT runs myriad of programmes such as technology incubation facilitation centres, courses for knowledge augmentation, entrepreneurship, start ups, business management and corporate partnership of industrial sector. In the past two decades, FITT has promoted the Intellectual Property Right (IPR) prominence of IIT-D by filing more than 200 IPR applications. It has aided the licensing of ~40 technologies developed in the institute in the last 10 years. Close to 15 spin-offs have graduated and another 15 start-up companies are current residents at the incubation facility of FITT. This I-A interface has grown into a successful self-sustaining centre having plenty of financial reserves in the form of bank deposits and company shares (~ INR 356 million as of 2014-15 financial year). The establishment of centers like FITT in various universities across India will act as a catalyst for enhanced I-A activities, which will culminate into increased number of technologies/ products/ patents and thus contributing to technological advancements and strengthening of the economy of nation.

INTRODUCTION

In 21st century, I-A collaborations have become a subject of great interest to academicians, industry leaders and policymakers, as it is now acknowledged that scientific innovations will be the key driver of the economy of the nations. For innovations of applied nature, strong research collaboration between industry and academia is imperative.

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In the developed countries, universities and private sector have effective and flourishing I-A bond and many successful I-A models exist. Whereas in the developing nations, the collaboration between the academia and the industry has not been harnessed to its full capacity. India, a developing country and presumably one of the futuristic top global economy of the world, currently ranks 50th in university-industry collaboration (Global Competitiveness Report 2015-2016). It has a vast network of over 700 Higher Education Institutes (HEIs) comprising of universities, Indian Institute of Technologies (IITs) and National Institute of Technologies (NITs), Indian Institute of Managements (IIMs). It also has over 300 national

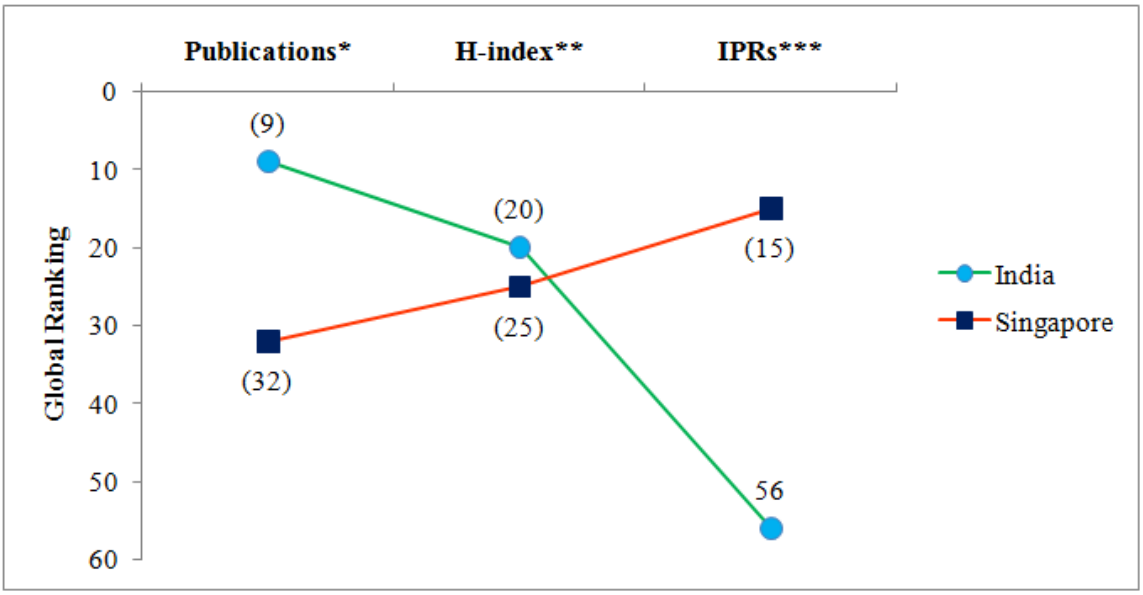
research laboratories as depicted in Table 1. In 2014, Indian scientists published nearly 114,500 research papers/articles and were globally ranked amongst the top ten nations of the world (SCImago Journal, 2014). Unfortunately, the quality of publications is not impressive, as the H-index value of 320 relegated India to a global ranking of 20.

India and Singapore on these indicators is illustrated in Figure 1. This data also implies that there is strong I-A interface in Singapore and India can learn a lot from its small Asian partner. The present Indian government is fully aware of the importance of effective I-A interface. The Department of Science & Technology (DST), Government of India (GoI),

Table 1. Higher Education Institutes/ National Research Laboratories in India

S.No.	Higher Education Institutes/ National Research Laboratories	Number
	Universities	
1.	Central Universities	46
2.	State Universities	342
3.	Deemed Universities	125
4.	Private Universities	228
	Technical Institutes	
5.	Indian Institute of Technology (IIT's)	18
6.	National Institute of Technology (NIT's)	31
	National Research Laboratories	
7.	Council of Scientific & Industrial Research (CSIR) Laboratories	43
8.	Department of Science and Technology (DST) Laboratories	25
9.	Department of Biotechnology (DBT) Laboratories	10
10.	Indian Council of Medical Research (ICMR) Laboratories	32
11.	Indian Council of Agricultural Research (ICAR) Laboratories	100
12.	Defence Research and Development Organisation (DRDO) Laboratories	48
13.	Department of Atomic Energy (DAE) Laboratories	13
14.	Indian Space and Research Organisation (ISRO) Centres	42

Source: http://www.csirhrdg.res.in, http://www.ugc.ac.in, http://www.icmr.nic.in, http://www.icar.org.in, http://www.dst.gov.in, http://www.dbtindia.nic.in, http://www.drdo.gov.in, www.isro.gov.in, www.dae.nic.in



*Source: * Scopus 2013. ** H-index: based on the set of most cited papers and the number of citations that they have received in other publications, Scopus. *** International Property Rights Index Report 2014*

Figure 1. Global ranking comparison of India and Singapore viz-a-viz scientific research output

The global ranking scenario looks more grim by considering another global indicator i.e. Intellectual Property Rights (IPR). India does not figure in the top 50 nations in IPR indicator (International Property Rights Index Report 2014). In comparison, Singapore, a small Asian country published 17,198 papers/articles and was globally ranked 32 (SCImago Journal, 2014; International Property Rights Index Report 2014). However, global ranking of 25 and 15 for H-Index value and IPRs clearly indicates that though Singapore not only publishes higher quality papers *vis a viz* India, but also converts its research outputs into innovative technologies/products at a high rate. A comparative analysis of

New Delhi has set up a Policy Research Centre at Panjab University, Chandigarh, India. One of the mandate of this Centre is to prepare an effective country specific model of I-A interface for Indian universities (http://cpr.puchd.ac.in/). As IITs are the hub of I-A interactions, a case study was carried out on the I-A centre established in 1995 and termed as Foundation for Innovation and Technology Transfer (FITT). Since its inception it has brought about a sea change in the number of patents and technology transfers. It is not only self sufficient in finances but also enjoys a corporate membership of over 300 companies. This article briefly describes the inception and governance of FITT (for details, please see the

article of Sengupta, 2009) and mainly deals with the various programmes/activities being conducted by FITT. FITT can serve as an effective model for the promotion of I-A interactions for India and other developing countries.

Inception of FITT

GoI established FITT in 1995 in the campus of IIT-D, a premier engineering institute of India by GoI as the first I-A interface (FITT Annual Report, 1994-95). The GoI at that time provided an amount of INR 16.2 million as an aggregated fund to IIT-D for initiation and build up of FITT. The mission statement of FITT was formulated as 'To be an effective interface with the industry to foster, promote, and sustain commercialization of science and technology of the institute for mutual benefit'. The centre was set up as an autonomous and self governing body, to act as a single window utility to the industrial sector with complete professionalism and function as a marketing arm for the IIT-D developed technologies (Sengupta, 2009). The broad organizational structure is composed of a) Governing Council and b) Research Council. The Governing council consists of representatives from industries; industrial associations and nominee from Ministry of Human Resources Development, selected nominated members from IIT-D senate and its board of governors. On the other hand, Research Council is composed of selected faculty members of IIT-D having experience in I-A collaborations. The management is vested with the Managing Director of the organization, guided by Governing Council and Research Council.

Programs and Services at FITT

Since the inception of FITT, a large number of programs and initiatives have been introduced in an effort to catapult the I-A linkages to the next level. The programs initiated by FITT can broadly be categorized as the following:

- Incubation Centers
- Research/Technology Development Projects
- Knowledge Augmentation Courses
- Intellectual Property Rights (IPR) Management Programmes
- Corporate Partnership for the Industrial Sector
- Government Schemes
- Memorandum of Understandings (MoUs) with Private Sector
- FITT Awards and Recognitions

Incubation Centers

In an endeavor to promote entrepreneurship and start-up companies, FITT initiated the task of setting up incubators/science parks on IIT-D campus, thereby providing easy access to students/ innovators. These incubation centers were set up with the aim of providing the entrepreneur with space for a prototype laboratory and other basic infrastructural and instrumentation facilities, without getting into the hassle of paper work. In addition, start-ups having credible business plan(s) with focused proprietary knowledge are promoted by FITT. It admits start-ups for an initial period of two years but an extension beyond the initial period is granted depending on the scope of the work. The incubator centre provides facilities such as product innovation, product development, software testing, pilot experimentation, simulation and prototyping, industrial training and technology related work which works in homology with the institute. Major activities of incubation centers are Technology Business Incubation Unit (TBIU), Bio-Incubator Facility, Science Parks and the units set up under Bio-Accelerator Programme. Various incubation facilities provided by FITT are as under:

Technology Business Incubation Unit (TBIU)

TBIU was started in 2000 under the aegis of Technology Institution Program (TIP), as a part of the Industrial Credit and Investment Corporation of India (ICICI)/World Bank Funded TIP at IIT-D (Bhattacharya, 2005). The TBIU program at IIT-D is aimed at promoting entrepreneurship among students, faculty and scientists and creating successful technology business enterprises for the future. Under this scheme, the start-ups/technology entrepreneurs are provided with an initial seed money and space for converting new ideas/concepts/service into a business opportunity that is commercially viable. This model has proven to be extremely helpful for the conversion of nascent technological ideas into commercial entities. TBIU, in its premises and in sync with the institute, permits activities such as innovative product development, software development and testing, simulation and prototyping, pilot scale experimentation, training and other works related to technology development. Thus, FITT not only provides modern infrastructure to the techno entrepreneurs but also provides for hand-holding, managerial and material support for establishing themselves. In return, minimal space utilisation charges and equity share of the company rests with FITT. The day-to-day administration of the TBIU lies with FITT. However, the management of TBIU rests with the TBIU board and a standing/screening committee, comprising of senior faculty scientists and industry experts from all over India to screen and evaluate the incubation proposals for entrepreneurs/start-ups admission to the TBIU.

Some of the successful examples of the start-ups graduated from FITT:

- ***Ekam ECO solutions Pvt. Ltd.***

Ekam Eco Solutions Pvt. Ltd. (www.ekamecosolutions.com) was initiated in financial year 2013-14 with the aim of providing ecological solutions in the field of nutrient recovery, water conservation, sanitation and sustainable habitat (FITT Annual Report 2013-2014). It works in the domains of sustainable livelihoods, sustainable sanitation and value-added bamboo products. Ekam has successfully commenced its objectives by addressing the gap in innovation and product development and is in the process of delivering out a number of innovative solutions which could be implemented at rural and urban levels. Global Corporate Social Responsibility (CSR) Excellence and Leadership Award 2015 was presented to Ekam in category of Social Impact Awards at APB News (www.ekamecosolutions.com).

Table 2. Start-ups (promoters/faculty) resident at TBIU during the financial year 2014-15

S. No	Start-up	Work area
1.	Novo Informatics Pvt. Ltd. (http://novoinformatics.com)	Bridging the gap between bio-informatics and experimentation
2.	Wring Nano Systems Pvt. Ltd. (http://www.truehb.com/team.php)	Advanced bioelectronics technologies (e.g. hemometer)
3.	PLANiN Innovation and Consultancy Services Pvt. Ltd.	Basket of innovative products with proprietary technologies (e.g. vehicool, smart wipes, flexible notice board etc)
4.	Silver Knight Technologies Pvt. Ltd. (http://www.silverknight.info/)	Development of Anti-Theft bag with unique features like pilfer proof casing, unique zip and lock mechanism & track and trace system
5.	Carbon Neutral Technologies Pvt. Ltd.	Develop an alternative manufacturing process for isoprene
6.	Kentellus Welding and Manufacturing Pvt. Ltd.	Production of welding electrodes of better quality using green technology
7.	Ekam Eco Solutions Pvt. Ltd. (www.ekamecosolutions.com)	Ecological solutions in the field of sanitation, water conservation, nutrient recovery and sustainable habitat
8.	Inkilab Technologies Pvt. Ltd. (http://www.inkilabtechnologies.com)	Diagnostics based technologies to facilitate process design
9.	Credext Technologies Pvt. Ltd. (http://www.credextechnologies.com)	Development of falcon virtual PC device that enables a user to access his/ her desktop at remote locations
10.	Creditas Solutions Pvt. Ltd.	Developing online platform for debt negotiation and settlements
11.	Innovator Lab Consultants India Pvt. Ltd. (http://www.innovatorlabindia.com)	Development of mechanical heart valve fixation system
12..	VM Trans Innovations Pvt. Ltd.	Development of intelligent online platform for road transport management and exchange system

(Source: FITT Annual Report, 2014-15)

Table 3. List of a few TBIU start-ups graduated into successful companies

S. No.	Name of the Incubating Unit	Technology /product /process in incubation	Residency	
			Entry	Exit
1	M/s eCapital Solutions Pvt. Ltd. / Trigyn Technologies (I) Pvt. Ltd.	Telecommunication and internet application	1999	2001
2	Sintex ESCO	R&D on insulated lightweight prefabricated building structures for thermal comfort and energy conservation	2001	2003
3	M/s INRM Consultants Pvt. Ltd. (http://inrm.co.in)	GIS based integrated watershed management	2002	2004
4	M/s KritiKal Solutions Pvt. Ltd. (http://www.kritikalsolutions.com)	Computer vision and image processing, wireless adhoc networks	2002	2005
5	M/s Mechartes Researchers Pvt. Ltd. (http://www.mechartes.com)	Software products for simulation of product development in auto component industry	2005	2008
6	M/s SM OnYoMo Infotech Pvt. Ltd.	Consumer searches over the internet	2005	2009
7	M/s LeadInvent Technologies (http://www.leadinvent.com)	Novel drug discovery & computational biology	2007	2010
8	M/s Appin Software Security Pvt. Ltd. (http://www.appinonline.com)	Software security	2007	2009
9	M/s Care-pro Biotechnologies Pvt. Ltd. (http://www.careprobio.com)	Fermentation based biomolecules	2007	2010
10	M/s. Sunurja Renewable Energy Pvt. Ltd. (http://www.sunurja.com)	Design and development of renewable energy solutions	2008	2011
11	M/s. Faros Technologies Pvt. Ltd. (http://www.farosindia.com)	Development of simulator sub components, simulators and providing simulation services	2008	2013
12	M/s. Innovative Transport Solutions Pvt. Ltd. (http://www.itrans.co.in)	Scientific and technical solutions for traffic and transport systems and development of models for sustainable transport for cities	2008	2012
13	Gram Vaani Community Media Pvt. Ltd. (http://www.gramvaani.org)	Building innovative models of media delivery for rural areas of india	2009	2013
14	Yonyx Infomedia Pvt. Ltd.	Building teacher replication platform to enable teachers to pack instruction with predicted student interaction	2010	2012
15	Innovative Mechatronix Solutions Pvt. Ltd.	Design, development and manufacture of micromachining system, mass production finishing processes and mechatronic embedded systems	2010	2013
16	Simplyfeye Softwares Pvt. Ltd. (http://www.simplyfeye.com)	User-friendly operating platform for biopharmaceutical manufacturers to capture, share and analyze information from biopharmaceutical processes	2010	2013
17	Genesis Location Services Pvt. Ltd. (http://genesis-locationservices.com)	Location based products and services	2011	2014
18	Novo Informatics Pvt. Ltd. (http://novoinformatics.com/)	Scientific software application products/tools	2011	2014
19	Wring Nano Systems Pvt. Ltd. (http://www.truehb.com/team.php)	Advanced blood haemoglobin testing POCT	2012	2014
20	Ekam Eco Solutions Pvt. Ltd. (http://www.ekamecosolutions.com)	Ecological solutions in the field of sanitation, water conservation, nutrient recovery and sustainable habitat	2013	2015
21	Inkilab Technologies Pvt. Ltd. (www.inkilabtechnologies.com)	Analytics to the manufacturer on defective parts and processes	2013	2014

(*Source: http://www.fitt-iitd.org*)

- ***Novo informatics Pvt. Ltd.***

Novo Informatics Pvt. Ltd. (http://novoinformatics.com) was founded at the TBIU in 2012 and has recently begun its commercialization and scale-up on independent grounds. It has developed software products like geno-analyzer, novo-proteomics, novo-genomics and disease specific database drawing a bridge between bio-informatics and experimentation. Presently, IIT-D is its research partner.

- ***Genesis location services Pvt. Ltd.***

Genesis Location Services Pvt. Ltd. (http://genesis-locationservices.com) was established in 2014. This start-up has developed on-board attendance system for business process outsourcing (BPO) employees and school children with global positioning system (GPS) tracking their vehicles. Start-up also came up with smart sub-station monitoring system for electrical distribution for companies. It can also monitor the real time parameters of transformer, as well as remote data collection from meters using GPS technology. It has successfully created a wireless connectivity option from Rajasthan Technical University (RTU) to supervisory control and data acquisition (SCADA) using transparent channel modem for companies dealing with electricity transmission.

- ***Kritikal solutions India Pvt. Ltd.***

The first faculty-student led business incubation unit, KritiKal Solutions India (Pvt.) Ltd. (http://www.kritikalsolutions.com), was founded in 2002. The company started functioning as a full-scale commercial venture by the year 2005 (Annual Report, 2005-06). The main focus of the company is embedded system design and real time computer vision and imaging solutions. As of date, KritiKal can boast of significant presence in India and United States and is also extending to Europe, Africa and other parts of Asia.

- ***Gram Vaani community Media Pvt. Ltd.***

Another successful spin-off from TBIU is GramVaani (http://www.gramvaani.org), based at IIT-D since 2008. It is a social technology based company, which provides information and community technology based solutions. This company works in collaboration with the institute and encourages internship/trainee students to work on real-life problems and situations. The company is now a 35 employee strong group and has recorded turnover of INR 10-15 million per annum. The company has also won several awards including The Knight News Challenge (2008), The Manthan Award (2009), The Economic Times Power of Ideas award (2010), The Rising Stars in Global Health award (2012) and The mBillionth Award South Asia (2012 and 2013). The TBIU clearly renders a proactive approach towards a judicious and long term partnership amongst the entrepreneur, institute and the outside world. A list of resident companies in the year 2014-15 is depicted in Table 2 (FITT Annual Report, 2014-15). The above-mentioned list of start-up companies is just a glimpse of what TBIU has done in order to promote entrepreneurship via the I-A interface. In the last two decades, there have been innumerable start-ups and incubates at TBIU and quite a few of them have graduated and are working independently as successful, self-sufficient, profit generating companies (Table 3).

FITT as a Biotech Ignition Grant (BIG) Partner

BIG is one of the highly successful I-A interface programmes of Biotechnology Industry Research Assistance Council (BIRAC), an autonomous body of Department of Biotechnology (DBT), GoI, New Delhi. BIRAC is a section 25 company and is actively involved in transforming the efforts of start-ups into commercially viable products and technologies. The BIG scheme, which aims to invite proposals for the ignition grant twice a year, supports entrepreneurs from the academia and research institutes for the commercialization of technologies resulting from research in the area of biotechnology, which has been recognized as an emerging and conspicuous area for growth. BIG has identified a few institutes, including FITT, as official partners. As a partner in the scheme, FITT holds the responsibility of screening the applications received; review the projects that have been shortlisted, provide mentoring in issues related to IPR, legal affairs and other business development related issues, facilitate interaction with experts of the field and other academic partners of the institute etc. An early stage grant by BIG is provided for the development of an invention into a marketable product. This is a one of a kind scheme, which aims at establishing and validating proof of concept ideas and thereby enabling spin-offs, which is now gaining pace. Some of the key projects under BIG partnerships are:

- Cutting Edge Medical Devices Pvt. Ltd. (http://www.cemd.in) developed portable analyzer SCINTILLA for detection of protein levels in urine samples.
- Sakosh Biotech Pvt. Ltd. is working on development of lateral flow immunoassay based rapid diagnostic tests for various infectious diseases.

Bio-Accelerator Programme

In 2013, FITT in association with National Institute of Immunology (NII) at New Delhi and BIORxVenture Advisors (http://www.biorxventureadvisors.com) started a Bio-accelerator programme, which laid emphasis on "accelerating innovation to marketplace" (FITT Annual Report,2013-14). This is indeed one aspect of research, which is now gaining pace, and this program provides the impetus to focus on innovation on the basis of market demands. It is a joint initiative to strengthen the bio-economy of the nation by composing a 'Master Class on Bio-entrepreneurship'. This programme is devised for working executives, research scholars and post-doctoral scientists who aspire to work towards a path of commercialization for their discovery.

Biotech Incubator Facility

The Department of Biotechnology, GoI, has recommended supporting the establishment of a Biotech Incubator Facility at FITT, IIT-D (FITT Newsletter, October 2014). A sanction of INR 87 million has been granted for the incubator, for a period of initial three years. This facility, like other incubators, will support start-ups and provide incubation facilities for research

and development work at minimal charges so as to promote innovation in the field of biotechnology. Further, FITT, with funding from BIRAC, has established a Biotechnology Business Incubator Facility (BBIF) which was inaugurated in August, 2014.BBIF provides incubator facilities such as specialized equipments, experimental facility, IP guidance, market linkages etc. to the budding bio-tech start-ups (FITT Annual Report 2014-2015). It provides for a very fertile/conducive environment and has a capacity for incubating close to 15 companies/entrepreneurs.

and development. These parks have been conceptualised in a way such that they will have all facilities for start-ups as well as well established firms. These facilities include legal, banking, research & development, consultancy, networking spaces and so on. In lieu of this concept, a land space of 50 acres for extension of IIT Delhi's research campus and the setting up of a Science and Technology Park, a centre for development of faculty and a high performance- computing centre was been allocated (Indian Institute of Technology Delhi eNewsletter, April 2013).

Table 4. List of technologies developed at IIT-D and licensed through FITT since 2002

S. No.	Year	Technology Licensed
1.	2002-03	Know how transfer of fiber optics educational kit
		Low molecular weight organic compound using liquid carbon dioxide
		Pilling tester based on digital image processing
2.	2003-04	Three phase watt hour meter
		RUSTGARD (Industrial grade & superior grade)
		Microwave Integrated Circuit (MIC) Kit
3.	2004-05	Local FE stress analysis and know how transfer of ASME Div-two reactors for Panipat refinery expansion
		Transfer of technology for *Trichoderma*
		Drape meter based on digital image processing
4.	2005-06	Technology transfer- VCO and detector
		Technology for manufacture of alluritic acid
5.	2006-07	High pressure bio gas (Gobar Gas) enrichment and bottling system
		Statistical scenario analysis software package
		Vehicle under side scanner
		Design & development of reusable pilfer proof currency carrying FRP cases
6.	2007-08	Computer aided design of components at microwave frequencies
		Design and development of active microwave integrated circuit trainer kit
7.	2008-09	Limiting torque bolt mechanism
		A smart cane for obstacle detection for the physically impaired
		A novel back panel design for efficient heat transfer in solar cells
		Polymer composite sheets with enhanced properties
8.	2009-10	RF magnetron target holder
		Selective and sensitive detection of mercuric ion by novel dansyl-appended Calix[4]arene molecules via fluorescence quenching
		An apparatus and method for packet error correction in networks
		System and method for decorticating hard shell seeds and fruits
9.	2010-11	Development of the iontophoratic kit for a transdermal delivery of methotrexate and insulin and validation of iontophoratic parameters for diclofenac
		Odourless, waterless urinal traps and associated structures
10.	2011-12	An apparatus for measuring fabric hand value
11.	2012-13	Real time based supervisory control of AC drive
		A method for preparation of cross- linked protein coated micro-crystal
12.	2013-14	Knowhow for the technologies on drug discovery and proteomics
		In-plane wicking measurement system
13.	2014-15	A small chaperone
		Thermal NDE: Modelling framework for crack detection
		A process of generating magnetically controlled ball and smart abrasive laden shape for finishing 3D intricate shaped surface
		Odour prevention device
		Concrete vibration sensor technology

Source: FITT Annual Reports (2002-15)

Table 5. Intellectual Property (IP) Licenses executed during 2014-15

S.No	Title	Client
1	A small chaperone	Theramyst Novobiologics Pvt Ltd, Banglore
2	Thermal NDE: Modelling framework for crack detection	GE India Technology Centre Pvt Ltd, Banglore
3	A process of generating magnetically controlled ball and smart abrasive laden shape for finishing 3D intricate shaped structure	Innovative Mechatronix Systems Pvt Ltd
4	Odour prevention device	Ekam Eco Solutions Pvt Ltd, New Delhi
5	Concrete vibration sensor technology	Central Electronics Ltd, Delhi

Source: FITT Annual Report (2014-15)

Science and Technology Parks

The most recent endeavour of FITT is to set up Science and Technology Parks as a way of promoting the institute's intellectual capital and providing a platform for better research

Research/Technology Development Projects

The faculty at IIT-D in collaboration with students and/or companies take up several research projects, which eventually lead to the development of technologies that are consequently

transferred or commercialised with the help of FITT. It is mainly involved in the transfer of technologies to the industry, initiation of joint research programs, consultancy assignments from the industry. The centre has aided the licensing of technologies developed at the institute; ~40 technologies have been licensed since 2002 and further ~10 technologies have been successful converted into commercially viable market products (Table 4). One of the most successful projects has been the development of the 'Smart Cane for the Visually Impaired', which was developed as an improvement to the white cane and defeats the limitation of white cane by detecting knee above and hanging obstacles (Singh *et al.,* 2010). This unique device was developed in collaboration with Phoenix Medical Systems, Chennai (industrial partner) and Saksham Trust, Delhi (NGO working for the visually impaired). Some other successful technologies that have been developed and commercialised are "FruWash" and "EnNatura". FruWash is an emulsion, which is biodegradable and can be used to increase the shelf life of harvested fruits and vegetables (without refrigeration). This technology was designed with an objective of reducing the post harvest losses in the horticulture sector. EnNatura developed offset printing biodegradable ink, using vegetable oils that tend to replace the standard inks that are based on petrochemical products/ crude oils.

association with the institute, introduced several knowledge augmentation & skill enhancement courses as well as a number of short-term courses devised on emerging technologies. For encouraging professionals to enhance their qualification, programs have been initiated so as to give professionals a chance to study while they work which will aid their professional growth. Various courses are offered by all departments of IIT-D e.g., Electrical Engineering, Computer Science and Engineering, Mathematics, Mechanical Engineering etc. One such programme initiated was "Professional Candidate Registration (PCR)". This course involves registration of the candidate for one semester (as per the course chosen) and is certified at the end of the program. A graduate in engineering sciences or a post graduate in science and management studies with relevant industrial experience is eligible for enrolment in these courses. This program is confined to the Delhi region as of now due to accessibility issues although a few selected courses are covered under the on-site delivery program by a two-way audio-video link. Another programme that was initiated was "Knowledge Augmentation and Skill Enhancement programme". Various add-on courses for professionals and students have been commenced with the aim of honing the students to be job ready.

Table 6. Select foreign collaborative projects (2014-15)

S.No	Title	Client
1	Optimization and growth of pyroelectric thin film stack	Ultrasolar Technologies, Inc, USA
2	Optimization of chromatography process steps for purification of monoclonal antibody based therapeutics	Purolite Limited, UK
3.	On line Devanagri handwritten character recognition on a smartphone through touch interface	Qualcomm Inc, USA
4	Polypropylene foaming and recyclability	Borealis AG, Australia
5	Advice for development of long term monitoring	Asada Lab, University of Tokyo, Japan
6	EEG signal based recognition module with low computational load	Safran, France
7	Algorithmic framework for MEMS sensor fusion applications	ST Microelectronics, USA

Source: FITT Annual Report (2014-15)

FITT undertakes short to medium term problem solving investigative projects that help in establishing mutual confidence and working relationships with industrial sector and is continuously working on transferring technologies outside. During the financial year 2014-15, 96 technology development/ transfer projects of worth INR 168 million have been contracted. Out of these projects, 5 Intellectual Property (IP) licenses were executed in financial year 2014-15 (Table 5). FITT also undertakes selected investigative projects involving foreign contribution that aid in technology development and asset share between national and foreign research partners. Some of the successful foreign collaborated projects of year 2014-15 are listed in Table 6.

Knowledge Augmentation Courses and Professional Development Programmes

Undeviating from its objective of knowledge transfer, FITT is working towards delivering academic options via various professional and human resource developments (HRD) courses. It understands that higher education is a continuing process and there is no limit to the enhancement of one's qualifications. In order to facilitate this increasing demand and providing a platform for working professionals, FITT in

This also includes HRD programs such as conferences or short workshops for knowledge updating of the latest happenings in various fields. The centre regularly assists the faculty of the institute in designing and organizing national and international workshops/conferences concentrating on prevailing field of science and technology. A few workshops/conferences that were recently conducted focused on renewable energy technologies, inclusive and frugal innovation etc (FITT Annual Report 2014-15).

Some of the specialized training programmes conducted by FITT are listed below:

- Advance Course of Software Engineering (S.Tech)
- Short Course on "Embedded Systems and Its Applications"
- Training Program on Fibre Optics for ONGC
- Certificate Programme in Telecom Technology in Management
- "Super Critical Power Generation Technologies"
- Certificate Course in Bioinformatics & Computational Biology

Other programmes conducted by FITT for academicians and industry employees are as follows:

- Frost & Sullivan's Technology Partnership Program: Initiated by IIT-D has access to the Frost & Sullivan's portal thereby getting useful market, technology and econometric information along with the latest updates on technology trends across a broad range of industry sectors (FITT Annual Report; 2014-15).
- Technology Incubation and Development of Entrepreneurs (TIDE) and Entrepreneurial and Managerial Development of SMEs through Incubators (MSME scheme): Adopted by FITT to enrich the entrepreneurial ecosystem and technology commercialization efforts at the institute.
- FITT in association with BIRAC and ABLE conducted short courses on Economic and Financing of Renewable Energy Technologies and Nascent Entrepreneurship Development Programme (FITT Annual Report, 2014-15).
- FITT also organized various seminars and awareness workshops for disseminating technologies developed at IIT-Delhi and promotional material and processed applications proposals. One such latest series of seminar on innovation, sustainability and entrepreneurship was organized by FITT in association with Knowledge Resource Development and Welfare group of IIT-D and PHD Chamber promoting entrepreneurship (FITT Annual Report, 2014-15).

Intellectual Property Rights (IPR) Management Programmes

Another important programme initiated by FITT is the IPR management of the institute's academic community. Before FITT had taken up the responsibility of promoting the IPR interests of the institute, the rate of filing for IPRs by the institute was very low. A number of campaigns were initiated at FITT for promoting IPR filing for novel inventions/technologies/research outputs amongst the academic community. Complete assistance for filing of applications was provided by FITT by way of evaluation of proposals for patents and other IPR applications for the final submission to Indian Patent Office and other establishments. The decisions pertaining to the application of technologies are taken by the IPR standing committee. The licensing policy followed by FITT is pliable and the payment terms are mutually secured.

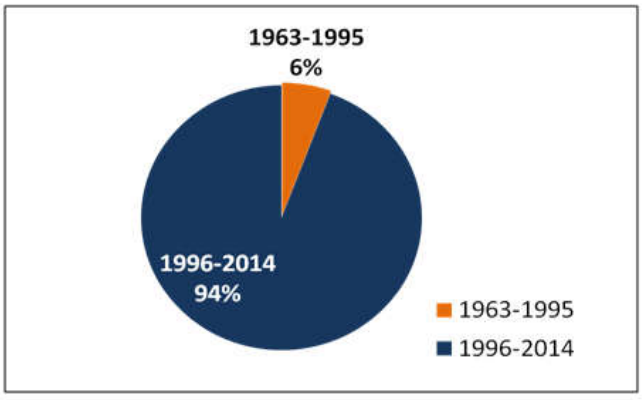


Figure 2. Patents filed before and after the inception of FITT

A comprehensive list of the technologies developed and being developed can be accessed from FITT website (http://www.fitt-iitd.org). This makes it extremely easy for the industry to search for any technologies of their interest and contact the person in question hence boosting the institute's technology commercialization. Since the inception of IPR body in 1995, FITT has seen enormous growth with respect to IP generation and technology transfer and in the process it has become more than self-sufficient financially (Figure 2). In the past two decades, more than 200 IPR applications have been filed in the form of patents, copyrights, designs etc. as opposed to a mere count of 15 patent applications filed from IIT-D between the years 1963 and 1995 i.e. before the inception of FITT (Figure 2). The probable projects are submitted to the IPR standing committee, where each project is discussed and thought over in detail for the grant of approval to be further submitted for IPR filing. In the year 2014-15, the IPR standing committee of FITT approved 27 technologies, and 5 IP licenses have been executed for technology transfer from academia to industry (FITT Annual Report 2014-15).

Corporate Partnership

The fundamental endeavor of FITT is to create an effective relationship between the institute and the industry on a mutually supportive basis. FITT has also started a corporate partnership program on the payment of nominal annual fee, for public and private sector industries, ministries and organizations and industry associations and financial institutes, and offers the advantage of concessional services to its members. The corporate members are regularly updated with the information of various programs at the institute and other opportunities of collaboration. FITT has a large number of big corporations as their corporate members, and with the numbers increasing every year; this clearly seems to be beneficial for the corporate. The corporate members receive, among other benefits, advance notifications of all patent applications/ technologies available and marketed by FITT, customized research presentations and seminars, industrial trainings and workshops, newsletters and select information. Most significant, however, is the advantageous working relation that the member develops with FITT thereby allowing them to gain access to research performed at IIT-D, as well as a variety of local businesses and services. As of date, more than 250 companies worldwide have benefited from the programs of FITT (http://www.fitt-iitd.org).

This number speaks volumes not only about the success of the organization but also about the way in which the industry is ready to collaborate with the academia. Some corporate members that are a part of this are: Pfizer India Pvt. Ltd, L'Oreal India Pvt. Ltd., LG Electronics India, Fresenius Kabi Oncology Ltd., Samsung Research Institute, Delhi, Dabur Research Foundation, Cube Software Pvt. Ltd., Reliance Industries Ltd., National Thermal Power Corporation, Bharat Heavy Electricals Ltd, Munjal Showa Ltd., JCB India, Canon India, Danfoss Industries, Carborundum Universal, Tata Chemicals, Jubilant Organosys Ltd., National Research and Development Corporation, Indian Grameen services etc. Recently, FITT has collaborated with one of the leading pharmaceutical company Pfizer for promoting healthcare innovations in country by commencing IP Programme for young entrepreneurs (Laha, 2015) to provide training and short courses in IP related issues but also to support development of technologies in healthcare sector. Under this corporate

collaboration individual support system for healthcare innovations are provided. This is one of the programme that directly involves active working of wet-lab based biotechnology business incubation facility of FITT which was set up only a year ago to meet growing demands among biotechnology/ healthcare sector. The collaboration has resulted into "the Pfizer IIT Delhi innovation and IP programme (PIDIIP)" which will provide funding support of upto INR 4.8 million, majorly into two sectors one is from idea to IP and other is IP support. Gamut of advantages can be availed by health science innovators in this facility where engineers, scientists and healthcare professionals are engaged together for solving challenging assignments for developing healthcare innovations that can address some of the issues that our country faces in the healthcare sector (Laha, 2015).

Government Schemes

FITT is also actively involved in the facilitation of all technology based government schemes. It provides for background checks on government technology development projects. Some of the prominent government schemes that are facilitated by FITT are listed below

N-WISE: The National Information System for Science and Technology (NISSAT–DSIR) Window to Information Services to Entrepreneurs was initiated in 2001-02.

Technopreneur Promotion Program *(TePP)* by Department of Scientific and Industrial Research (DSIR) and Technology Information, Forecasting and Assessment Council (TIFAC) of the Department of Science and Technology (DST):FITT has taken up various programmes to enrich the ecosystem of entrepreneurship and technology transfer at the institute, one of them being TePP. FITT is a partner in the program initiated by DSIR & TIFAC and also one of the TePP Outreach Centres (TUCs), wherein a financial support of up to INR 1.5-4.5 million is provided by DSIR and all the technical support & mentoring for development of an idea/prototype of the project is provided by FITT.

Entrepreneurial and Managerial Development of Small and Medium scale Enterprises (SMEs) through Incubators: This scheme was started for the promotion of knowledge/technology based innovative ventures, in all fields of science and technology, to improve the competitiveness of SMEs, through a financial support of up to INR 40.1 million.

PRISM (Promoting Innovation in Individuals, Start-ups and MSMEs): This program initiated under the aegis of DSIR, aims to support one of the most crucial agenda of the XIIth Five Year Plan (2012-17) i.e. inclusive growth and development. This scheme provides support to prototype/models with upto INR 0.2 million and fabrication of working model/process know-how/testing & trial/patenting/technology transfer upto INR 2-5 million. This program, which is offered in two phases, promotes the development of technologies needed in the market and the transfer of IP of such developed technologies, which is where a major gap lies, mainly due to the lack of funds by start-up firms. FITT as a confederate, through this scheme helps in promotion of the development of such technologies, which could otherwise be shelved only due to lack of resources.

Department of Information Technology-Technology Incubation and Development Entrepreneurs (DIT-TIDE): Department of Information Technology (DIT) has introduced Technology Incubation and Development of Entrepreneurs (TIDE) for providing seed support in the broad area of IT development. FITT has partnered for promoting this scheme, which provides incubators during early stages of the development of various IT and ITES enabled firms.

Memorandum of Understanding (MOU)

Formal agreement between FITT and other institutes/industrial partners has been set up to promote innovation and technology transfer. Some of the advantageous MoUs (2014-15) are mentioned below

- MoU with the American Society for Quality (ASQ) India Pvt. Ltd: An MoU was signed with ASQ India Pvt. Ltd., with a central agenda of achieving forwardness in knowledge/adeptness and its implementation for the benefit of IIT-D community in fields of engineering and management sciences. It also aimed to add virtue for the executives working in the industrial sector and government sector through continuing education. ASQ, being the global knowledge framework that it is, links the best ideas, tools, and experts together, and offers globally accepted individual certification in programs such as six sigma, TQM, process management, etc.
- MoU with Security Printing and Minting corporation of India Ltd (SPMCIL), New Delhi to foster collaboration on research, training and professional development and exchange of technical expertise in areas of mutual interest including material science and testing capabilities.
- MoU with Global Aerospace, Defence and Security Leader, Safranto initiate research and development in the area of advance machine learning.
- MoU with Wallonia Foreign Trade and Investment Agency (AWEX), Belgium in order to create high-profit sustainable global companies from pioneering start-ups using Wallonia as a hub for their expansion in Europe to gain access to the markets in the European Union.

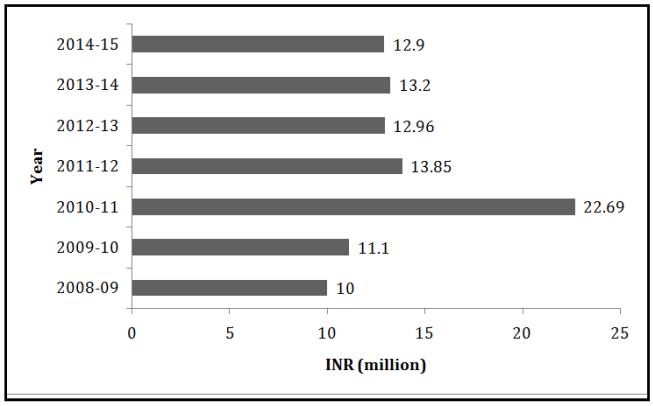
FITT awards and recognitions

FITT, in order to promote the spirit of innovation and entrepreneurship has launched various appreciation ceremonies in the form of awards and rewards. These activities are generally carried out in collaboration with various corporate players and are as follows.

- Launch of Industrial Credit and Investment Corporation of India (ICICI)-trinity program: The program launched by ICICI for budding entrepreneurs is an initiative of the bank to reward innovation and entrepreneurship amongst the youth community in India. The ICICI Trinity programme comprises of three stages – idea generation, prototype and be an entrepreneur. This program has been launched in several top institutes across the country, with IIT-D being one of them.

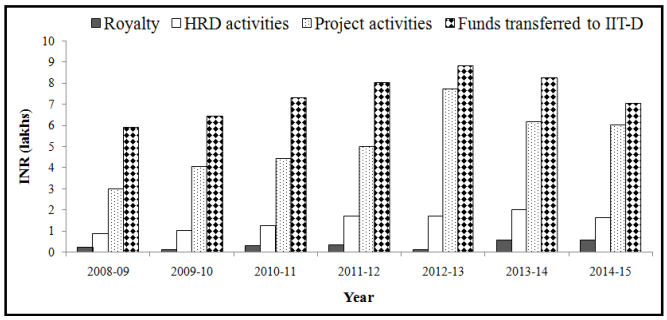
- POSOCO power system award (PPSA)-2015: The Power System Operation Corporation (POSOCO), a wholly owned subsidiary of PowerGrid Corporation of India Ltd., launched these awards, in the form of cash prizes, to recognise the outstanding contribution made in the field of power systems and its related fields. The collaboration with FITT encompasses the IITs and National Institute of Technologies (NITs) in order to motivate individuals and encourage further research activities in the area of power system.

FITT has instituted two awards one each for Ph.D and M.tech/ M.S projects as best industry relevant projects through which financial and marketing assistance is provided to award winners to incubate their project.



(*Source: FITT Annual Report, 2008-15*)

Figure 3. Asset Generation (infrastructure, equipments and transfer of funds) from FITT for IIT-D



(Source: FITT Annual Report, 2008-15)

Figure 4. Resource generation for FITT and IIT-D

Financial Synopsis

FITT has not only promoted the intellectual and infrastructural facilities of IIT-D but also added industrial relevance and commercial value to the academic knowledge/ research being performed at IIT-D. Among the many functions and objectives of FITT, marketing and business development is one of the most important aspects of FITT. It is the only way of advertising the expertise available at IIT-D that led to enormous asset generation for FITT and IIT-D. FITT has bank deposits and bonds worth INR 356 million in financial year 2014-2015. Major earnings of FITT came from interests (INR 33 million), project activities (INR 6.6 million) and corporate membership fees (INR 0.1 million) for the year 2014-15. On the other hand, total expenditure of FITT cost around INR 13 million. Thereby, leading to an operational growth worth INR 177 million from projects and other activities performed in financial year 2014-15. Financial assets generated by FITT were achieved by conducting I-A summits, active participation in industry exhibitions at national and international level, publication of a quarterly bulletin, regular propagation of knowledge about IIT-D and FITT through means of articles and write ups in newspapers/magazines and occasional promotional advertisements, initiating corporate membership scheme for the industry, establishment of relationships with associations like Federation of Indian Chambers of Commerce and Industry (FICCI), Associated Chambers of Commerce & Industry of India (ASSOCHAM), Confederation of Indian Industry (CII) and so on. Figures 3 and 4 depicts the asset and resource generation for IIT-D by FITT since 2002.

SUMMARY AND CONCLUSIONS

FITT is one of the highly successful models of I-A interface in India, which can be adopted and embraced by the developing countries. This model aims to bridge the gap between the industrial sector and the academic sector and brings many benefits (tangible and intangible) to its stakeholders i.e. academia and industry. The tangible benefits include creation of entrepreneurs, who later on become owners of start-up companies. In other words, a job seeker becomes a job employer. I-A centres like FITT helps scientific community in bringing its research outputs to the market by way of patenting their innovative research and preparing a business model for their applied research. The setting up of FITT in IIT-Delhi has seen tremendous increase in the number of patents; technology transfers, innovative products, financial gains and creation of first generation entrepreneurs which has greatly enhanced the branding of the institute. FITT also provides many intangible benefits to the academia. The scientists of IIT-Delhi do not have to worry about the commercial gains of their research out puts and thus can devote 100% of their time in teaching young and bright minds as well as carrying out high end research. Getting state of the art technologies, which gives them a global edge in the highly competitive market, also benefits industry. India has enormous scientific strength as evidenced by its high global ranking (9^{th}) for the indicator of number of research publications. In addition, Govt of India has introduced many schemes, such as DST-INSPIRE faculty scheme, Ramalingaswami Fellowship by DBT, Ramanujam Fellowship (DST) and Prime Minister's Fellowship Scheme for Doctoral Research etc. for encouraging young bright researchers, residing in India as well as abroad, to join universities. India can reap the harvest of its scientific intellect for solving the research problems of industrial sector by opening FITT like centres in the universities which are actively publishing high impact research papers in international journals. By adopting FITT model for the promotion of I-A interactions, we cannot even comprehend the advantages it might provide, not only in financial terms, but by way of promoting the development of indigenous technology, creating entrepreneurial spirit and thereby boosting the Indian economy.

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