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FLCTD

Facility For Low Carbon Technology Deployment

TECHNOLOGY TRANSFER OFFICE HANDBOOK

Prepared By

VENTURE CENTER

ACKNOWLEDGEMENTS: This publication was prepared for the United Nations Industrial Development Organization (UNIDO) by Venture Center, based on the key insights from senior and experienced practicing Technology Transfer Office (TTO) professionals who have had years of hands-on experience setting up, operating and growing technology transfer activities in distinguished organizations. The publication also consists of focused guidelines and recommendations that stems from Venture Center's 18+ years of experience operating its own technology transfer office.

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Technology Transfer Office Handbook

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Message from BEE

Dhiraj Kumar Srivastava
Chief Engineer, Ministry of Power, Government of India
Director General, Bureau of Energy Efficiency

The Government of India set up the Bureau of Energy Efficiency (BEE) on 1st March 2002 under the Energy Conservation Act, 2001. The mission of the Bureau of Energy Efficiency is to take all measures for the overall framework of the Energy Conservation Act, 2001. Some of the notable work includes the energy conservation and sustainability and implementation of energy conservation standards for appliances, vehicles and Industries, Carbon Credit Trading Scheme, Assistance in Deploying Energy Efficient Technologies in Industries & Establishments (ADEETIE) scheme, Energy Conservation and Sustainable Building Codes, and Demand Side Management initiatives to enhance energy efficiency.

India became a climate leader by being the only large emerging economy to respond to the call for increased ambitions by announcing the goal to double the rate of energy efficiency improvement rate, achieve Net Zero emissions by 2070. Innovation assumes a greater role in bringing out low-carbon technologies, which present benefits such as a reduction in greenhouse gas emissions and a reduction in demand for energy imports.

In partnership with the United Nations Industrial Development Organization (UNIDO), BEE is implementing the Facility for Low Carbon Technology Deployment (FLCTD) to identify, validate, and promote such high-impact innovations. The programme has demonstrated that India possesses tremendous technical talent and ingenuity. What is needed now is stronger technology transfer capacity to bridge the gap between research excellence and real-world industrial adoption.

Supported by the Government of India's commitment to fighting climate change, Indian academic institutions conduct high-quality research and develop competitive low-carbon technologies and technical solutions for adoption by industrial and domestic end-users. Technology transfer is a well-recognized enabling process allowing academic Research & Development and technology improvements to be channelled into applicable products and solutions.

Innovation is central to this journey. Breakthrough technologies—whether emerging from laboratories, start-ups, or industrial research—hold the power to dramatically reduce greenhouse gas emissions, strengthen energy security, and open new avenues for green growth. Realizing this potential requires robust mechanisms that can convert ideas into impactful solutions adopted at scale.

In this context, I am delighted that Venture Center, Pune has developed the Reference Handbook for Technology Transfer Offices under the FLCTD programme. This handbook provides practical guidance to strengthen institutional capabilities in technology commercialization, intellectual property management, and industry engagement. More importantly, it encourages academic researchers, innovators, and industry leaders to work together in accelerating solutions that can transform India's energy landscape.

I commend the FLCTD Project team for producing this timely resource. I am confident that this handbook will inspire institutions and innovators nationwide to translate ideas into action and scale technologies that will shape a more energy-efficient, sustainable, and resilient future for India

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Message from UNIDO

The partnership between the Government of India and the United Nations Industrial Development Organization (UNIDO) has steadily evolved to strengthen the country's progress towards sustainable industrialization. Guided by the 2030 Agenda for Sustainable Development and the UNIDO Country Programme for India 2023-2027, UNIDO continues to advance its mandate of promoting sustainable industrial development in India.

In 2016, UNIDO, in collaboration with the Bureau of Energy Efficiency and with the support of the Global Environment Facility (GEF), launched the Facility for Low Carbon Technology Deployment (FLCTD). The project promotes the identification, demonstration, and validation of innovative low-carbon technologies across industrial, commercial, and agricultural sectors. It also focuses on strengthening institutional capacities through the development of Technology Transfer Offices (TTOs) in higher education and research institutions, which serve as vital intermediaries in transferring innovations from the laboratory to the market.

Building upon the lessons learned from a national-level gap analysis on "Technology Transfer Centers to Increase Commercialization of Innovations", conducted under the FLCTD initiative, UNIDO partnered with the Venture Center in 2024 to develop a suite of knowledge products addressing the specific challenges and opportunities within India's innovation ecosystem. As part of this collaboration, Venture Center has piloted a foundational training programme and, together with the FLCTD Project Management Unit, developed this Technology Transfer Office Handbook as a key resource for institutional capacity development.

This handbook consolidates research insights, practitioner experience, and practical strategies to support effective management and operation of Technology Transfer Offices. It is envisaged as a reference guide to strengthen institutional mechanisms for knowledge exchange, technology commercialization, and industry engagement.

The publication also contributes to the broader efforts of UNIDO to promote innovation and technology transfer as enablers of resilient industrial development. It represents an important step towards strengthening national capacities for science, technology, and innovation, thereby supporting India's pathway to energy transition and the achievement of its net-zero ambitions.

Through initiatives such as this, UNIDO reaffirms its commitment to supporting the Government of India and its partners in advancing inclusive, sustainable, and innovation-driven industrial growth. We extend our sincere appreciation to all partners, stakeholders, and contributors who have played a valuable role in developing this resource and in strengthening India's innovation ecosystem.

Dr. Cristiano Pasini
Director and UNIDO Representative

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Message from Venture Center

It is increasingly evident that science- and technology-led innovation will play a defining role in the industrial development of nations. Building indigenous capabilities in research, technology development, and innovation is essential for every country as it strives to address unique local challenges and global priorities such as climate change, environmental degradation, and sustainable growth. In delivering the benefits of scientific and technological progress to society, academia and research institutions serve as pivotal actors. They not only shape emerging industries and keep existing industries competitive, but also train the next generation of leaders and provide critical know-how to solve complex problems.

To effectively translate knowledge into industrial and societal impact, Technology Transfer Offices (TTOs) within academic and research institutions play a central role. They help forge and shepherd productive partnerships between knowledge institutions and industry, functioning as orchestrators of innovation impact. By connecting a diverse network of stakeholders—funders, academia, government laboratories, start-ups, and industry—TTOs act as a keystone in any innovation ecosystem. Recognizing this crucial function, organizations such as UNIDO, national government bodies, charitable foundations, and innovation-focused incubators like the Venture Center have emphasized strengthening TTO capabilities as a strategic priority.

This Technology Transfer Office (TTO) Handbook has been designed as a practical guide for academic and research institutions seeking to establish and operate effective TTOs. It brings together best practices from advanced economies as well as practical insights from emerging innovation ecosystems such as India. Rather than focusing on the theory of technology transfer, the Handbook emphasizes the operational dimensions of creating, managing, and scaling a TTO. To complement this resource, the TechEx.in team at the Venture Center has developed an accompanying manual containing curated readings and video materials, available at https://manual.techtransfer.online.

We believe this Handbook can serve as a foundational reference for India's Science, Technology, and Innovation (STI) ecosystem. By equipping technology transfer offices and innovation professionals with structured, practice-oriented knowledge, this initiative aims to contribute meaningfully to India's pursuit of an innovation-led economy—one that also advances sustainability, supports energy transition, and accelerates progress toward net-zero ambitions.

Premnath Venugopalan, PhD
Director, Venture Center

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Acknowledgements

The Venture Center extends its sincere gratitude to the United Nations Industrial Development Organization (UNIDO) for conceptualizing this Handbook and entrusting us with its preparation. We believe this TTO Handbook will make an important and useful contribution to the innovation ecosystems not only in India but also in many other countries striving to build vibrant innovation-driven economies. We also thank the Bureau of Energy Efficiency (BEE) and the Global Environment Facility (GEF) for their support of this initiative.

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Finally, this TTO Handbook would not have been possible without the dedicated efforts of the TechEx.in team at the Venture Center, including Ms. Pradnya Aradhye, Ms. Meghana Bhandari, Dr. Manisha Premnath, Ms. Manasi Lele, Ms. Archana Joshi, Dr. Vidula Walimbe, Ms. Shruti Devasthali, Ms. Neha Jacob, Mr. Rohit Joshi, Ms. Niruta Killedar, Dr. Mugdha Lele, Dr. Kavita Parekh, and Mr. Vedang Pawar.

Our heartfelt thanks to all who made this TTO Handbook possible.

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List of Abbreviations

Sr. No	Abbreviation	Full form
1	AUTM	Association of University Technology Managers
2	BEE	Bureau of Energy Efficiency
3	BIRAC	Biotechnology Industry Research Assistance Council
4	BU	Boston University
5	CC	Creative Commons
6	CCMB	Centre for Cellular & Molecular Biology
7	CFTRI	Central Food Technological Research Institute
8	CLP	Certified Licensing Professional
9	CNG	Compressed Natural Gas
10	CRM	Customer Relationship Management
11	CSIR	Council of Scientific & Industrial Research
12	CTF	Community Technology Fund
13	CTIER	Centre for Technology, Innovation, and Economic Research
14	CTO	Chief Technology Officer
15	DNA	Deoxyribonucleic Acid
16	DST	Department of Science & Technology
17	EPC	Erection, Procurement and Commissioning
18	EPR	Extended Producer Responsibility
19	ESG	Environmental, Social, and Governance
20	ETV	Environmental technology verification
21	EU	European Union
22	EV	Electric Vehicle
23	FITT	Foundation for Innovation and Technology Transfer
24	FLCTD	Facility for Low Carbon Technology Deployment

Sr. No	Abbreviation	Full form
25	FRAND	Fair, Reasonable and Non-Discriminatory Licensing
26	FSU	Florida State University
27	GEF	Global Environment Facility
28	GHG	Green House Gas
29	IISER	Indian Institutes of Science Education and Research
30	IIT	Indian Institute of Technology
31	IOT	Internet of Things
32	IP	Intellectual Property
33	ISRO	Indian Space Research Organization
34	LCA	Life Cycle Analysis
35	LIC	Low Income
36	LLC	Limited liability company
37	LMIC	Low medium income countries
38	LTE	Long-Term Evolution
39	MACS-ARI	Maharashtra Association for the Cultivation of Science-Agharkar Research Institute
40	MIT	Massachusetts Institute of Technology
41	MMV	Medicines for Malaria Ventures
42	MPEG	Moving Picture Experts Group
43	MPP	Medicines Patent Pool
44	MSME	Micro, Small & Medium Enterprises
45	MTA	Materials Transfer Agreement
46	NASA	National Aeronautics and Space Administration
47	NCL	National Chemical Laboratory
48	NDA	Non-Disclosure Agreement

Sr. No	Abbreviation	Full form
49	NIRF	National Institutional Ranking Framework
50	O&M	Operations and Maintenance
51	OTL	Office of Technology Licensing
52	P&L	Profit & Loss
53	PAIR	Partnerships for Accelerated Innovation and Research
54	R&D	Research and Development
55	RTTO	Regional Technology Transfer Office
56	RTTP	Registered Technology Transfer Professional
57	SATAT	Sustainable Alternative Towards Affordable Transportation
58	SEP	standard essential patent
59	STI	Science, Technology, and Innovation
60	TCRM	Techno-Commercial Readiness and Market Maturity
61	TIFR	Tata Institute of Fundamental Research
62	TLO	Technology Licensing Office
63	TT	Technology Transfer
64	TTO	Technology Transfer Office
65	TTP	Technology Transfer Professionals
66	UN	United Nations
67	UNIDO	United Nations Industrial Development Organization
68	USB	Universal Serial Bus
69	VC	Venture Center
70	VPC	Value Proposition Canvas
71	WIPO	World Intellectual Property Organization

About the TTO Handbook

This Technology Transfer Office (TTO) Handbook is meant to be a concise handbook for aspiring or practicing technology transfer professionals in academic and research organizations. The TTO Handbook is also meant to be a primer for top leadership of academic and research organizations who are planning to set up TTOs in their organizations.

The TTO Handbook aims to distil and present key insights from senior and experienced practicing TTO professionals who have had years of hands-on experience setting up, operating and growing technology transfer activities in distinguished organizations. It is not the aim of this book to focus on theory and frameworks, but practically applicable insights.

Technology transfer and technology transfer offices come in many flavours depending up on the mandates and orientations of the parent organization! This TTO Handbook is especially suited for TTOs serving research (understood here as new-knowledge creation activities) organizations that also create know-how and inventions during the course of research. This usually includes many higher education institutes, research universities and government research labs that carry out original research and have (or are building) a track record of inventive outputs or science and technology-based spinouts. Organizations that identify the creation, protection and commercialization of creative works and intellectual property as mission-critical activities are likely to find this TTO Handbook especially useful.

This TTO Handbook is aimed at academic and research institutions that nurture science and technology based “deep science” or “deep tech” ideas and seek out partners (as industrial licensees or nascent start-ups) who can create societal and economic impact with these ideas. One important sub-domain of the deep tech innovations is the domain of Clean Technology – a topic central to the UNIDO-BEE-GEF project titled “Facility For Low Carbon Technology Deployment” that has commissioned the creation of this TTO Handbook. It is clear that efficient and effective technology transfer from technology developers/ owners to technology seekers/ deployers will be a key determinant of the pace at which Clean Technologies are deployed globally to slow down/mitigate/ reverse the impact of Climate Change. And this key task shall fall on the shoulders of TTOs like the ones we are trying to equip with the necessary skills and insights via this TTO Handbook.

Happy reading!

Section 1 :

Technology Transfer: Helping research organizations in demonstrating visible impact for society

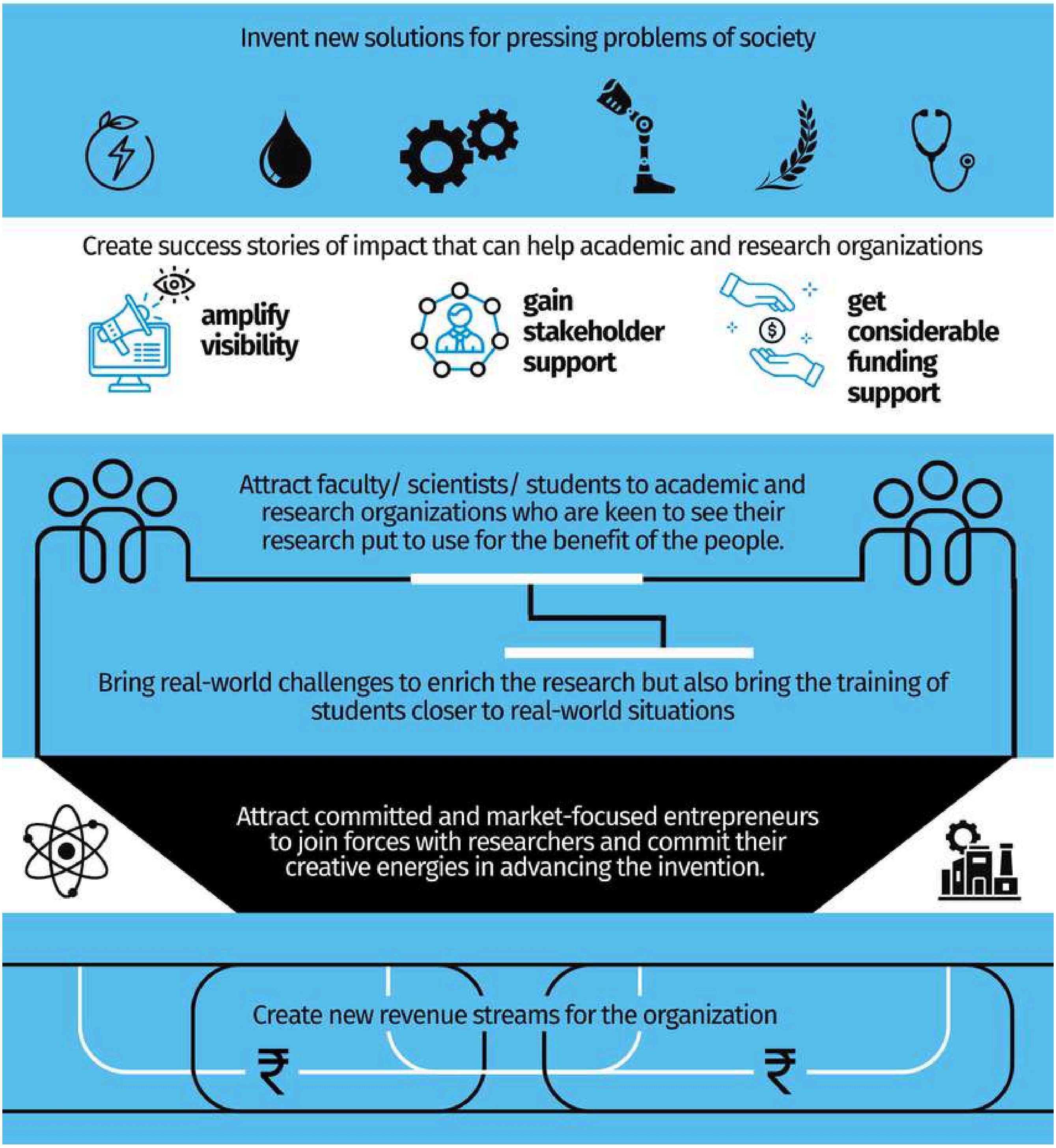

Figure 1 : Technology Transfer: Helping research organizations in demonstrating visible impact for society

Introduction to Tech Transfer

This section introduces the field of Technology Transfer, explains its important role in facilitating the journey of a technology from research to market by undertaking various activities from protecting inventions to marketing them and fostering collaborations with commercialization partners.

1.1 What is Technology Transfer?

Technology transfer (TT) is the process of moving industrially useful knowledge created in academia and research institutions and putting it to practical use in industry and start-ups for producing products and services that can eventually deliver socio-economic impact for society (Definition developed by Venture Center that is more relevant for academic and research organizations).

TT is a key component of a larger umbrella of Knowledge Exchange (KE) mechanisms that allow academia and research universities (as creators and disseminators of knowledge) transmit and industry and start-ups (as entities that utilize and exploit knowledge to create socio-economic impact) exchange knowledge and know-how. The other components include movement of knowledge workers, consulting, scientific services and R&D collaborations.

> Technology transfer (TT) is the process of moving industrially useful knowledge created in academia and research institutions and putting it to practical use in industry and start-ups for producing products and services that can eventually deliver socio-economic impact for society.

In practice, TT is not merely the handover of knowledge and technical information to a commercialization partner but involves several other activities that make possible the transaction and partnership. These can include identifying and developing commercialization partners, effectively communicating the uniqueness and benefits of the useful knowledge, ensuring adequate intellectual property protections, conceptualizing and implementing an agreement between partners that supports the commercialization journey effectively while ensuring that all parties reap a fair share of benefits, managing contracts through their life cycle and also creating an ecosystem that nurtures industry-academia collaborations.

In established academic and research organizations, the TT operations are undertaken by a Technology Transfer Office (TTO). The TTO serves a strategic function for the academic or research organization by providing it a key mechanisms of demonstrating to its stakeholders the usefulness of its knowledge creation activities and forging ties with industry. Given the complex nature of a TTO's operations, the TTO is staffed with Technology Transfer Professionals (TTPs) who usually combine (in different proportions) training and experiences in science/ engineering/ medicine, science communication, contract and intellectual property law, marketing and portfolio management, and industry or entrepreneurial experience.

As one of the core functions of the technology commercialization process, the technology transfer function institutionalizes the process by establishing formal documentation, assigning stakeholder roles, and providing a legal framework to create structured pathways for taking R&D outcomes to the market. The structured and chronological documentation of intellectual property disclosures, IP filings, non-protected knowledge assets, transfer agreements, milestone achievements, and stakeholder accountability creates a verifiable trail that supports negotiations with industry partners, fundraising efforts, and the resolution of legal disputes. Thus, the technology transfer function actively strives to balance the individual, societal, and commercial aspects of creating, protecting, and leveraging knowledge assets.

"Technology transfer" in other contexts

The term technology transfer is also used in a few other contexts. For example, technology transfer can also be used to mean a transfer of industrial know-how and accompanying intellectual property from one company to another. Several Indian companies benefit from in-licensing of proven and mature technologies from global corporations. Another area where one notices use of the term technology transfer is in the pharmaceutical and specialty chemicals sector where technology transfer is used to connote a transition of know-how from the R&D department to the manufacturing department. In this handbook, we are limiting the discussion on technology transfer to the transition of know-how from academia and research organizations to industry.

1.2 The need and importance of technology transfer

Technology transfer has today become the keystone of innovation-led societies and economies.

One framework (used by Global Competitiveness Index Report of World Economic Forum) of economic development classifies economies as being either factor-driven economies, efficiency-driven economies or innovation-led economies. Factor-driven economies rely on the natural resources in their control and the economy depends on exploitation of natural resources (like oil reserves, minerals etc) or production of goods using natural resources (like agriculture, aquaculture etc). Efficiency-driven economies rely on their ability to deliver increased productivity (higher value for lower cost). Examples of industries from efficiency-driven economies include several manufacturing sectors, outsourced IT and engineering services etc. On the other hand, innovation-led economies are characterized by value creation that leverages new ideas and human creativity. The key asset being worked for useful outcomes is intellectual property. Every country has different extents of their economy being factor-driven or efficiency-driven or innovation-led. One will also notice that many of the most affluent societies of the world today are innovation-led economies with a few notable exceptions of nations with access to abundant natural resources (like oil reserves). As of the date of writing this handbook, India is largely an efficiency- driven economy blessed with some but limited natural resources. The Government of India is keen to build a strong innovation-led economy as India aspires to become a developed nation. Technology Transfer will be key to helping India achieve this goal.

> Technology transfer is key to helping countries build a strong innovation-led economy!

If one observes carefully, Innovation-led economies are often characterized by centers of academic and research excellence that create and disseminate knowledge actively, and also nurture an ecosystem in the neighbourhood where knowledge exchange and the pursuit of innovation can happen rapidly and seamlessly. Classic examples include the innovation ecosystems of Boston, Silicon Valley, Cambridge UK, Oxford, Stockholm, Tel Aviv, Beijing and Singapore. A mature understanding of Tech Transfer and systematic efforts to foster industry-academia relationships have been one of the reasons for the emergence of these innovation ecosystems. The Association of University Technology Managers (AUTM), USA publishes periodic reports on the economic impact of technology transfer and the most recent report has documented that as of 2020, University technology transfer contributed to more than 1 trillion $ to the GDP of the USA, supported more than 6.5 million jobs, helped create more than 18,000 start-ups and deliver 200+ drugs and vaccines to the world. Thus, it is clear that academic and research organizations hold considerable potential for nucleating and catalysing socio-economic impact, and the technology transfer profession has the considerable responsibility of serving as champions and enablers of this opportunity for society and the economy.

> As of 2020, University technology transfer in the USA contributed to more than 1 trillion $ to the GDP of the USA, supported more than 6.5 million jobs, helped create more than 18,000 start-ups and deliver 200+ drugs and vaccines to the world.
> (Source: Association of University Technology Managers, USA).

Having an effective and efficient technology transfer operation is also a great asset for academic and research organizations. Tech transfer helps academic and research organizations demonstrate their usefulness to society and economy in many visible ways other than educating the next generation of leaders and workers for society. This could be inventing new solutions that solve pressing problems of society relating to health, rehabilitation, energy, environment, agriculture, food, mobility, materials, infrastructure etc. Creating such success stories and then effectively communicating them can help academic and research organizations gain stakeholder support and considerable funding support (that can often far exceed the direct technology transfer income of these organizations). Having effective technology transfer operations also attract faculty/ scientists/ students to academic and research organizations who are keen to see their research put to use for the benefit of the people, thus creating a virtuous circle of attracting the right talent and delivering impact. Technology transfer operations are also responsible for corporate engagement and thus help bring real-world problems to academic researchers thus adding new dimensions to their academic and research program which not only enrich the research but also bring the training of students closer to real-world situations. In the last 3 decades, start-ups (as opposed to license to established firms) have increased their share in commercializing research from academia and research organizations - a phenomenon that is increasingly attracting budding innovators and entrepreneurs to academic and research organizations. Having innovators and entrepreneurs working in close association with researchers presents a considerable opportunity for researchers to advance their technologies closer to widespread use with potential societal and financial impact. Finally, technology transfer presents an opportunity for academic and research organizations to create new (albeit relatively smaller and unpredictable but unconstrained) revenue streams for the organization.

MYTH

TT is a distraction to the main activity of teaching

No. Technology development and its translation to actual products/ services of use to society not only provides access to real-world problems to researchers, but also trains students in real-world topics. It also inspires and attracts faculty/students who are motivated by serving society through technology.

MYTH

TT is a commercial activity

No. Technology transfer is a vehicle to realize the mandate of most academic / R&D organizations to disseminate knowledge and know-how, and bring the benefits of knowledge to the society. TT is a delivery mechanism for impact.

1.3 The journey of technology from research to market

One of the top priority activities of academic and research organizations is new knowledge creation. Knowledge creation focuses on observations, discoveries and inventions. One can think of knowledge creation activities in three kinds :

- Know-what: Facts, observations, description, concepts, classifications
- Know-why: Theories, causation, mechanism
- Know-how: Methods, tools, techniques, recipes

While all knowledge creation activities are foundationally crucial to any technology development activities, it is the “know-how” kind that is directly related to technology development. The first two types of knowledge (“know-what” and “know-why”) are primarily domains where academic and research organizations play a leadership role.

The third type of knowledge (“know-how”) is where academia and industry are both stakeholders and often need to engage with each other effectively in order to create value for society and the economy, and this is where Tech Transfer Professionals (TTPs) play a key role!

The journey of technology translation is rarely linear or monotonous in pace. Every technology journey has its twists and turns, phases with accelerated progress and phases with setbacks and reverses. That said, for successful technologies, the overall direction of progress has some key milestones which are listed in the table below.

Activity	Outcome
Conception of the technology idea.	Solution conceptualized for an unsolved problem or unmet need. Could be an invention. A technology developer may use tools for visualization, detailing, designing etc
Proof of concept experiments	Experimental evidence that show reduction to practice of the conceived idea. Experimental evidence that demonstrates that the core idea in the concept works!
Protecting IP (if applicable)	Early filings for registration of IP such as patent applications
Multiple rounds of prototyping and technology de-risking; Scaleup for process technologies	Fully functioning prototype albeit not at full scale or finish; Detailed understanding of the prototype; Data available for understanding technical feasibility and commercial viability.
Protecting IP	Further IP protection; Clarity on IP strategy
Internal/ external testing, Testing for reliability; Repeatability, reproducibility, robustness.	Prototype works predictably and as expected.
Pilot/ batch manufacturing	Able to reliably produce trial quantities for advanced testing/ trials
Proof of value studies	Evidence for unique value being created by the product for customers compared to other alternatives
Certification testing; Testing as per standards; Validation studies.	Certifications; Pre-clinical/Clinical studies; Field trials
Manufacturing	Supply chain, production, inventory management etc in place
Regulatory submissions	Regulatory approvals/ clearance
Market entry	Product commercially available

Table 1: Typical phases of technology development
(Note: The below stages of technology development reflect the stages seen for innovations in the manufacturing sector. The stages reflect the broad direction of progress all though details can vary from case to case.)

The journey of a technology, as outlined in the table above, involves multiple key milestones that an innovator must progressively achieve. This journey often requires input from a broad range of expertise—spanning science, engineering, intellectual property, and validation studies Depending on the sector, these validations may involve agricultural specialists (in the agri-industry), clinicians (in healthcare), or automotive experts (in mobility), among others.

Compliance with industry-specific standards, certifications, and regulatory frameworks also plays a crucial role. Given this complexity, technology development is rarely a solo endeavor; it is typically a collaborative effort involving multidisciplinary teams. The duration of the journey can vary significantly across different industries. For instance, drug development — from discovery research to regulatory approval — can span up to 12 years.

It is well recognized that the later stages of development (typically after conception and proof of concept stage) demand significantly higher investments of time, effort, and resources compared to the early phases (conception, proof of concept).

As a result, the substantial costs and risks associated with these later stages often necessitate collaboration and risk-sharing among multiple partners. This underscores the critical importance of academia–industry partnerships in enabling successful technology translation.

1.4 Various routes to commercializing and exploiting knowledge

In the past, technology transfer from academic and research organization meant a handover of know-how and IP rights to an industry partner, much like relay race where each runner hands over a baton to the next. However, in recent time, technology transfer professionals have been contributing to many different routes besides classical technology transfer to commercializing and exploiting knowledge. The academia-industry partnerships can take multiple forms and shapes depending upon the scope of roles and responsibilities of each partner and the stage at which the partnership is initiated.

Consequently, the journey of a technology beginning in an academic and research organization may take multiple routes to reach the market. The choice of the routes to market is often dependent on the nature of the technology, the costs and risks involved, the time lines involved, the complementing capabilities involved and the preferences of each partner. The table below lists a few common routes:

Routes	Description
Technology transfer	The academic/ research organization develops the technology idea to a certain stage and then transfers to a company to advance it further with minimum further involvement in form of advice and scientific support.
New venture creation	The academic/ research organization spins off a new entity (with or without involvement of the student/scientists/ faculty in the spinout) to commercialize the technology idea.
Contract technology development	A company contracts the academic/ research organization to carry out certain pre-decided phases of the technology development as a contract on a fee-for-service model.
Joint development	A collaboration between academic/ research organizations to jointly develop a technology clearly defining each other's roles, responsibilities, costs and rewards/ rights. There can be a whole spectrum of proportions of responsibilities and rights for each party depending on the specific case at hand.
Consortia mode technology development	Here a group of organizations get together to work on a technology development project of collective interest. For example, several industries (producers, users, traders) dealing with plastics may collaborate with a publicly funded academic institution to develop technologies for effective plastics recycling or disposal in the broader interest of the industries, economy, society and environment.

Table 2 : Example routes and mechanisms that a technology may take to market

Routes	Description
Mission mode programs and entities	In this model, governments or non-profit organizations may create a mission mode program (or an entity) with the focused goal of solving a large problem facing society. Towards this end, the mission mode programs/ entities may serve as vehicles that forge industry-academia collaborations necessary to accomplish the task at hand. For example, the Medicines for Malaria Venture aggregates resources, technology providers and commercialization partners to work towards the mission of new medicines for malaria.

Table 2 (continued) : Example routes and mechanisms that a technology may take to market

1.5 Overview of functions and activities of a TTO

TTOs are typically groups within an academic/R&D organization that undertake various activities aimed at achieving the strategic goals of translating research done in the academic/R&D organizations into tangible outcomes for the people/ society/ economy. Occasionally, there can be stand-alone TTOs that serve multiple organizations and may be referred to as Regional Technology Transfer Offices or Technology Marketing Entities. TTOs carry out multiple activities (which are discussed later); however, one can list the following three major categories of activities:

- Protection and management of intellectual property
- Technology marketing, business development and deal-making
- Managing and maintaining relationships with commercialization/ industry partners

The three pillars of TTO activities:

- IP management
- Business development and deal-making
- Building and managing relationships

Here are a few of the activities that TTOs carry out:

- Awareness, training, enabling policies
- Identifying/ sourcing technology assets
- IP protection and management
- Patent analytics for decision support
- Technology translation and readiness; innovation funding/Proof of Concept (POC) funding
- Technology assessment
- Technology marketing
- Advancing a lead closer to deal-making
- Technology transfer deal structures/ agreements
- Technology valuation
- Negotiations and closing a deal
- Post-deal contract life cycle management
- Tech venturing and spinouts; seed funding
- Other models of technology commercialization

In academic/ R&D organizations with considerable volume of inventions, the TTOs may be organized into cohesive and focused units as follows:

Unit 1: IP protection & portfolio management:

- Awareness, training, enabling policies
- Identifying/ sourcing technology assets
- IP protection and management
- Patent analytics for decision support

Unit 2: Valorizing technology assets:

- Awareness, training, enabling policies
- Technology assessment
- Technology translation and readiness; Innovation/ POC funding

Unit 3: Tech marketing and transactions:

- Technology assessment
- Technology marketing
- Advancing a lead closer to deal-making
- Technology transfer deal structures/ agreements
- Technology valuation
- Negotiations and closing a deal
- Post-deal contract life cycle management

Unit 4: Venturing & other routes to market:

- Awareness, training, enabling policies, clubs
- Tech venturing and spinouts; seed funding
- Other models of technology commercialization

These units have been classified above to reflect cohesiveness in terms of goals (for example, the focus of "Unit 1: IP protection & portfolio management" is to operate an efficient process for receiving invention disclosures, ensure that the patents are written well and inventions are protected well and that cost of filing/ prosecution/ maintenance is managed optimally. Their goal does not include advancing the technology, or marketing and licensing it or creating spin-offs).

The units are also classified keeping in mind the cohesiveness of professional training and expertise in each group (for example, the people managing "Unit 1: IP protection & portfolio management" will need to have a fairly good understanding of IP law as opposed to say, marketing or finance or deal-making).

While "Unit4: Technology marketing and transactions" activities are probably the most crucial set of activities to focus on for creating impact, "Unit 1: IP protection & portfolio management" activities is what is the starting focus for most nascent TTOs as creating a pool of "assets" to transact is an essential precursor to technology transfer.

In some institutions in the USA, TTOs have chosen to follow a "Case Management" approach where one Case Manager handles an invention across the activities listed under each units listed above. While this brings a holistic approach to commercializing each invention, it also places a high demand on TTO staff to have across-the-board and diverse expertise/ skills.

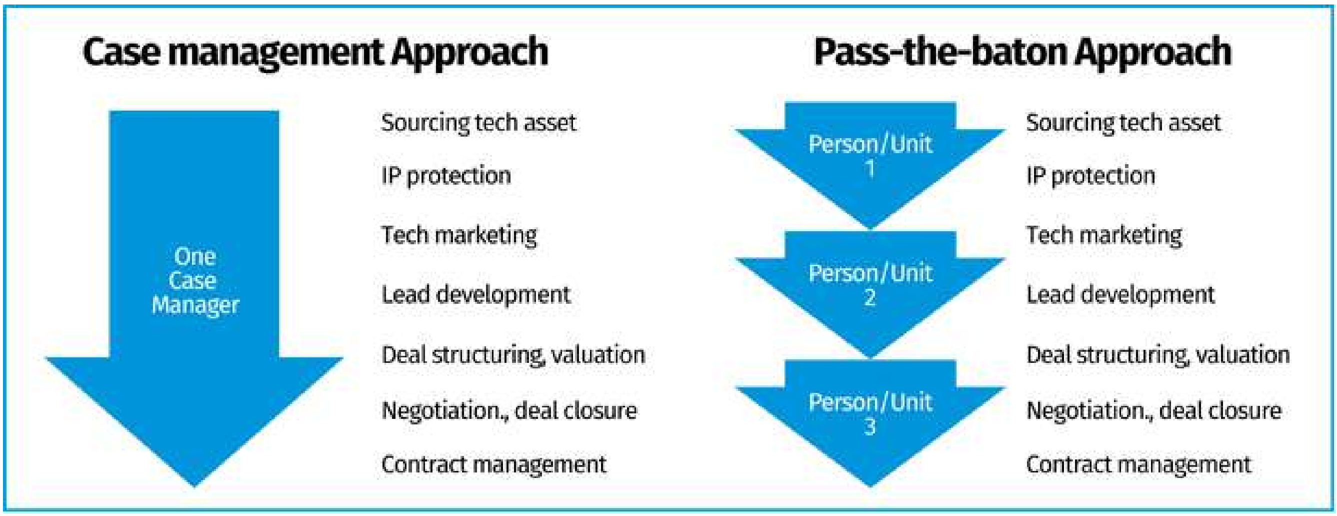

Figure 2 : Case Management Approach" vs "Pass-the-Baton Approach

In the Indian context, most academic/ R&D organizations do not have significant volumes of inventions to have multiple units However, in recent times, some academic/ R&D organizations (esp. the older IITs, CSIR labs) are building up a strong portfolio of inventions and may need multiple units with focused goals and skillsets to operate a TTO effectively.

Not all activities listed above need to be done in-house. Many can be outsourced to partners. Every academic/ R&D organization needs to optimize for itself how it can operate an effective TTO depending upon their own circumstances of availability of staff, ability to hire, processes for hiring external services and availability of funds.

The following are a list of functions/ activities that TTOs may wish to keep in-house:

- Awareness, training, enabling policies
- Identifying/ sourcing technology assets
- Contracts/ agreements with service providers
- Portfolio management of technology/ IP assets
- Internal workflows and decision points
- Decision making bodies/ individuals; decision support
- Funding allocations and cost management
- Technology translation and readiness; Innovation/POC funding

The table below lists activities that can be outsourced to potential partners:

Activity	Potential partners
• IP awareness, training • IP filing, prosecution, maintenance • Patent analytics and opinions	• IP attorney firms • IP / Patent Facilitation Centers • Patent strategy consulting firms/ organizations
• Technology marketing • Lead identification and development • Technology showcases	• Technology marketing agencies/ firms • Regional TTOs
• Technology/ IP valuation	• Specialist consulting organizations/firms
• Agreements drafting and suggesting suitable clauses	• Law firms • Agreement support by Regional TTOs
• Management of royalty agreements • Management of equity portfolios	• Tech asset management firms • Regional TTOs • Incubators
• Venture creation	• Incubators
• Seed funding	• Incubators

Table 3 : Activities of TTOs that can be outsourced to partners

1.6 Organized technology transfer: The need and history in India

(This section is based on text from "The Origins of Organized Technology Transfer in India: The NRDC Story, les Nouvelles - Journal of the Licensing Executives Society, Volume LVIII No. 1, March 2023)

Organized technology transfer (TT) is not new to India—in fact, the country has a rich legacy in this area that can inform and inspire present-day efforts. The roots of formal technology transfer in India go back to 1953 with the establishment of the National Research Development Corporation (NRDC). Created under the leadership of Sir Shanti Swarup Bhatnagar and supported by Prime Minister Jawaharlal Nehru, NRDC was tasked with developing and commercializing inventions from publicly funded research institutions, universities, and individuals for the public good.

From the 1950s to the mid-1980s, NRDC held a monopoly over public sector technology transfer, making it the cornerstone of India's innovation ecosystem. Given that the Indian government was the primary funder of scientific research at the time, NRDC played a central role in bridging the gap between research labs and industry. It took on multiple responsibilities: filing patents, marketing inventions, negotiating licenses, and even assisting in scale-up and certification efforts. Its legal and technical teams ensured smooth commercialization processes.

One of NRDC's early and most iconic successes was the licensing of indelible ink used in Indian elections. Developed by CSIR-National Physical Laboratory in the early 1950s, this ink was later patented and licensed to Mysore Paints and Varnishes Limited (MVPL). MVPL has continued to supply this ink for every Indian election since 1962 and even exports it to over 15 countries. This remains a powerful symbol of Indian science serving democratic and public interests.

NRDC also played a critical role in the development of India's infant food industry, by transferring technology from CSIR-Central Food Technological Research Institute to Amul. This innovation allowed the production of infant food from buffalo milk, reducing reliance on imports and increasing local availability during lean months. Under the brand Amul Spray, the product became widely distributed across the country.

In the context of the Green Revolution, NRDC facilitated the development and transfer of the SWARAJ tractor—a 20 hp tractor designed for small Indian farms. Created by CSIR-Central Mechanical Engineering Research Institute and licensed to Punjab Tractors Ltd, the tractor has since sold over a million units, becoming a staple in Indian agriculture and contributing to self-reliance.

In the biomedical field, NRDC enabled the indigenous production of blood bags and India's first mechanical heart valve (the Chitra Heart Valve) through partnerships with Sree Chitra Tirunal Institute and Peninsula Polymers Ltd. These breakthroughs not only reduced dependency on imports but also helped establish a domestic biomedical engineering industry.

Over its 70-year history, NRDC has managed over 2,500 technologies, filed 2,000+ patents, and signed more than 5,000 licensing agreements. It introduced India to the disciplines of intellectual property and technology transfer when these were practically non-existent, shaping a generation of skilled professionals.

Starting in the mid-1980s, NRDC started losing high-quality pipelines and had to compete for its technology pipeline and its terms of engagement with research institutions. Several of the national labs and publicly funded research universities went on to set up internal technology transfer offices. Some of the earliest technology transfer offices (often within so-called Business Development offices) that took shape in India were in CSIR labs (for example, in the National Chemical Laboratory). The Department of Biotechnology initiated creation of the Biotechnology Consortium of India Limited in 1990 to manage its technology transfer. IIT- Delhi created a foundation FITT in 1992 roughly modelled after WARF in the USA. The Indian Space Organization created Antrix in 1992. Several others followed.

In the last 70 years, India has seen and experimented with multiple models of Technology Transfer Organizations which has yielded some insights into on what worked and what did not in the Indian context.

However, one must realize that those eras were different in terms of its stage of development, its global standing and the global environment in which the country was operating. In the current context of building an innovation-led economy for India with an eye towards a Viksit Bharat, the imperative to reinvent and re-energize how academic and research organizations practice technology transfer is greater than ever.

In sum, India was a early-starter in organized technology transfer, long before many other emerging economies. However, organized technology transfer was limited to a few organizations, fragmented and not ubiquitous. As India now looks to build an innovation-led economy, strengthening its TT infrastructure and making TT a norm for every academic and research organization is a Imperative that India has to pursue and build drawing upon past experiences.

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UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION
Progress by innovation

2

Section 2 :

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Building and operating an effective technology transfer office including enabling policies and institutional mechanisms

This section describes key aspects on setting up and operating a TTO such as the role and positioning of a TTO in a research organization, enabling policies and guidelines, workflows, staffing, resourcing and impact reporting.

2.1. Organizational structure and positioning

In the leading academic and research organizations of the world, TTOs are positioned into the organizational structure as a strategic function rather than merely an administrative support function. This because the activities of TTOs have a direct relationship to how the academic and research organization translates research into socio-economic impact for society – one of the top deliverables for publicly funded academic and research organizations. This vital role is evident in the emphasis placed on key metrics—such as inventions, technology transfer, industry-academia collaborations, new venture creation, and entrepreneurial leadership among alumni and staff —in Governing Body meetings and the annual reports of academic and research institutions.

In most organizations, the TTO is a department/ office of the organization that is closely associated with the top functionary (Directors/ Deans typically) in the organization guiding overall research strategy, major research programs and industrial collaborations, and initiatives in innovation and entrepreneurship. For example, in the IITs, the Heads of TTOs or equivalents report to the Dean (R&D) while in CSIR labs, the Heads of TTOs (often called Business Development Divisions) report to the Director of the lab.

Occasionally, academic and research organizations have chosen to set up their TTOs as independent entities. For example, IIT Delhi has set up FITT as an independent entity. A few of the motivations behind setting up the TTO as an independent entity are as follows:

- Independence of the entity allows a sharper focus on technology transfer without getting caught up in the rest of the goals of an academic organization
- Having an independent entity may attract leadership talent for the TTO that is distinct from the leadership ladder in academic organization and also allow a separate career growth path and incentivization structure
- Having a separate entity may allow for operational flexibilities beyond the constraints of an academic and research organization.

Despite all the above mentioned motivations being attractive reasons for setting up a TTO as an independent entity, the fact remains that most TTOs around the world have not found a fully sustainable financial model to fuel an independent entity. Besides this, leaders of most academic and research organizations would like to see their TTOs focus on delivering the parent organizations goals rather than having a risk of diluting the focus by creating an independent entity with a larger or divergent mandate. Furthermore, having TTOs as independent entities can result in additional transactions (between the academia/ research organization and the TTO) and consequent complexity of transaction costs and related taxation. Independent TTOs often need impact reporting and performance evaluation by multiple stakeholders. Overall, TTOs as independent entities are uncommon and often not viable as standalone entities unless they have independent sources of income or funding.

The size and organizational structure of a TTO depends upon the role that technology outcomes play in the mandate of the organization, the intensity of inventive and entrepreneurial activity in the organization and the decision the organization makes on what activities it would like to outsource. Given below are organizational structures for a TTOs at different stages of maturity:

Maturity of TTO	Indicative structure

Nascent
(Low volume of inventions, TTO is < 2 years old; licensing yet to begin)
	Head/ Director, TTO
	○ Case Manager
	    ▪ (Outsourced) IP services
	    ▪ (Outsourced) Legal services
	○ Admin & Agreement follow-up

Emerging
(say, < 12 invention disclosures/ year; portfolio of less than 50 patents; licensing initiated)
	Head/ Director, TTO
	○ Case Manager (s)
	    ▪ (Outsourced/ Inhouse) IP services
	    ▪ (Outsourced) Legal services
	○ Manager -Outreach, awareness, promotion, marketing
	○ Admin & Agreement follow-up

Mature
(say, 50+ patents/ year; portfolio of 200+; has experience with licensing)
	Head/ Director, TTO
	○ Case Manager (s)
	○ Manager - IP
	    ▪ (Outsourced) IP services
	○ Manager- Outreach, awareness, promotion, marketing
	    ▪ (Outsourced) Technology marketing agencies
	○ Manager -New venture creation, entrepreneurship promotion
	○ Manager - Technology valorisation initiatives, POC fund
	○ Manager - Contracts
	    ▪ (Outsourced) Legal services
	○ Admin & Agreement follow-up

Table 4 : Indicative organizational structures for TTOs at different stages of maturity
(Note: The criteria used for classifying a TTO as nascent, emerging or mature is based on experiences with Indian TTOs)

In practice, many Indian academic and research organizations face several systemic and procedural constraints in terms of hiring and retaining specialized talent. At the same time, organizations may also be facing a financial or procurement process constraint in terms of engaging outsourced services.

In this context, organizations may wish to follow a strategy of systematic training and grooming of inhouse talent for the TTO (via training programs, internships and professional certifications) supplemented by external services as needed.

Organizational Charts of TTOs

Experienced and highly active TTOs can have multiple activities and focus areas. Organizational structure can be diverse. Here are a couple of examples:

- MIT Technology Licensing Office Organizational Chart:
  https://tlo.mit.edu/sites/default/files/2025-11/TLO%20Organization%20Chart%20%2821%29.pdf

- Emory University Office of Technology Transfer Organizational Chart:
  https://ott.emory.edu/_includes/documents/sections/about/contact/ott_org_chart.pdf

2.2. Policies and guidelines

Well-conceived and clearly drafted policies are crucial ingredients for TTO operations.

TTO- related policies must begin by acknowledging and aligning with the overall mission, vision and guiding principles of the parent organization.

The table below tries to illustrate how the organizational priorities of different academic and research organizations can be different.

	Academia **Ex: IISERs, IITs**	**Govt R&D Labs** **Ex: NCL, CCMB, TIFR**	**Production focused R&D Labs** **Ex: DRDO, ISRO**
Priority 1	Teaching; Dissemination of knowledge	New knowledge generation; Research training	"Production" R&D; Assemble, test, optimize, deploy
Priority 2	New knowledge generation; Research training	Create new know-how/ inventions; technology options; Impact via tech	Manage resource centers, collections; Capabilities bank
Priority 3	Create new know-how/ inventions; technology options; impact via tech	Manage resource centers, collections; Capabilities bank	Support industry by offering services
Priority 4	Manage resource centers, collections; Capabilities bank	Support industry by offering services	Create new know-how/ inventions; technology options; Impact via tech
Priority 5	Support industry by offering services	"Production" R&D; Assemble, test, optimize, deploy	New knowledge generation; Research training
Priority 6	"Production" R&D; Assemble, test, optimize, deploy	Teaching; Dissemination of knowledge	Teaching; Dissemination of knowledge

Table 5 : Illustration of how priorities of academic and research organizations can be different taking a sample of 6 priorities.

Here are a couple of observations on the table above:

- Organizational priorities can be different for different organizations. Hence, copying policies blindly is not a good idea.
- One will note the conspicuous absence of "income" as a priority. The reality is that for non-profit organizations "impact" is a priority and "income" is merely a means to supplement finances. Lita Nelson, ex-Head of MIT-TLO famously said about the goals of a TTO- "Impact, not income: It's not about the money.

Sure, we like it when our ships come in, but the primary focus is getting the deal done so that the technology gets developed."

Once the goals of the parent organizations are clear, the next task is to align the policies governing the TTO to those of the parent organization. This statement of alignment usually forms the "Guiding Principle" of the policy document. For example, a version of the policy document of MIT-TLO stated the Guiding Principles as follows – "The prompt and open dissemination of the results of MIT research and the free exchange of information among scholars are essential to the fulfillment of MIT's obligations as an institution committed to excellence in education and research. Matters of ownership, distribution, and commercial development, nonetheless, arise in the context of technology transfer, which is an important aspect of MIT's commitment to public service. Technology transfer is, however, subordinate to education and research; the dissemination of information must, therefore, not be delayed beyond the minimal period necessary to define and protect the rights of the parties." As one will observe, for MIT, Technology Transfer is a subordinate goal to education and research. This, however, may not be the case for a technology-development focused R&D organization like a DRDO lab. The Guiding Principle sets the tone and choices in the rest of the policy document.

> Policies governing a TTO's functioning are determined by the parent organization's missions and priorities. Since each academic/ research organization has different mandate and priorities, policies governing TTOs need to differ accordingly to reflect the parent organization's priorities

Depending upon the scope of activities of the parent organization and the scope of the TTO, some of the following policies may be needed:

- Intellectual property policy
- Technology transfer policy
- Revenue sharing policy
- Start-up/ spinout/ venture creation policy (esp. equity models)
- Faculty entrepreneurship policy
- Conflict of interest & commitment policy
- Student entrepreneurship policy

Policy documents typically aim to:

- Clarify the position of the organization on the subject including any statement indicating intention to promote certain activities and outcomes, or statements of priorities.
- Lay out the over-arching principles and choices that the organization has made (for example, who owns the IP created by employees).
- Provide legitimacy for certain activities and justify its role in the organization (for example, faculty starting start-up companies).

More details and example policy documents can be found in the Technology Transfer Online Manual. A few important clauses of above mentioned policies are mentioned in the table below.

Policy	Key aspects
Intellectual property policy	• Clarity on ownership of different types of IP created under different circumstances by different categories of creators • Obligation to disclose IP to the organization • Clarity on who will administer the IP • Clarity on who will bear the cost of filing and maintaining IP
Technology transfer policy	• Clarity on principles governing choices in how technology will be commercialized/exploited under different circumstances • Clarity on who will make the decisions and who will lead the commercialization activities including deal-making, agreement signing, collection of rewards etc
Revenue sharing policy	• Clarity on whether rewards from technology commercialization shall be distributed amongst the organization, the creators and the TTO • Policies that govern distribution patterns • Clarity on who will be responsible for administering the revenue sharing mechanism
Start-up/ spinout/ venture creation policy (esp. equity models)	• Clarity on whether the organization treats new venture creation as a separate category for encouragement and accords special policy support to that category (for ex, allowing preferences in licensing, concessional terms, equity based models etc)
Faculty entrepreneurship policy	• Clarity on whether the organization permits faculty to start companies. Providing legitimacy and acknowledging alignment of entrepreneurship activities with core responsibilities in the organization. • Special policies and incentives to encourage or support faculty entrepreneurship (for ex, provision to use sabbatical leaves to pursue start-up activity)
Conflict of interest & commitment policy	• Clarity on organizational position on staff managing their responsibilities with regards to their association with multiple organizations while ensuring no conflict of commitment or interest.
Student entrepreneurship policy	• Clarity on whether the organization permits students to start companies while studying. Providing legitimacy and acknowledging alignment of entrepreneurship activities with the students educational program. • Special policies and incentives to encourage or support student entrepreneurship (for ex, provision to substitute dissertation with a start-up project)

Table 6: Selected important aspects in policies relevant to TTOs

Policies are often accompanied by Guidelines that are meant to provide structure, framework and guidance for the organization to execute on the policy with clarity, predictability, efficiency and with minimum disputes. On-ground implementation of Guidelines requires the TTO to identify/set-up/roll-out:

- Institutional processes or workflows
- Decision points in the workflows
- Decision making authorities and authorization matrices
- Forms and templates
- Individuals or units that are in-charge of operating specific workflows

> Policies are often accompanied by Guidelines that are meant to provide structure, framework and guidance for the organization to execute on the policy with clarity, predictability, efficiency and with minimum disputes.

It is important to point out that Policies and Guidelines are not meant to be strategy documents (that make strategic and investment choices to achieve certain outcomes or impact goals) or roadmaps (that lay out a pathway implementing the strategy). Heads of TTOs often work closely with the top leadership of academic and research organizations to develop strategy documents and roadmaps. For more details and example policy documents, please visit the Technology Transfer Online Manual at https://manual.techtransfer.online

2.3. Workflows and institutional processes

A few important workflows in a typical TTO are listed in the table below along with a few indicative milestones in the workflow.

Workflow	Key milestones
Invention disclosure workflow Key documents/ formats: • Invention disclosure form • Patentability assessments • Patent specifications	• Receipt of invention disclosure from inventors • Meeting to identify/ define invention, potential claims and plan course of action • Preliminary patentability assessment • Decision to go ahead with first filing (and creation of accompanying information to support the case) • Drafting provisional specifications • Filing provisional specifications, securing priority date • Claim strategy (and accompanying necessary data collection, searches) • Drafting and filing complete specifications • Decision to go for PCT filing (and creation of accompanying information to support the case) • PCT filings • Decision to go for PCT filing (and creation of accompanying information to support the case) • "National" phase filings in foreign jurisdictions (Note: Post-filing, patent applications need to be prosecuted until successful grant or issuance of the patent. Following this, decisions need to be taken periodically on renewal of patents.)
Technology marketing workflow Key documents/ formats: • Tech Brief	• Discussions with inventors to understand invention, its use cases, value proposition etc • Desk research • Creation of Tech Brief (marketing document) • Outreach via various channels; outreach to targeted prospects • Leads generated

Table 7: Selected TTO workflows and key milestones

Workflow	Key milestones
Licensing workflow Key documents/formats: • Non-Disclosure Agreement (NDA) • Materials Transfer Agreement (MTA) • Term Sheet • Licensing Agreement • Technology Manual	• Lead qualification and advancement; includes meetings, sharing information etc • NDA signing • Detailed discussions and building conviction • Request for term sheet from licensee • Clarity on scope of transaction • Deal structuring • Term sheet with key terms • Negotiations and agreement on deal structure • Commercial proposal • Negotiations and deal closure • Signing of agreement • Licensing fee collected • Technology transfer including sharing of technology manual, tech demonstration, training and handover

Agreement monitoring workflow
 	
Key documents:
• Format for licensee to submit periodic reports
• Invoice
• Receipts
	• Start date of agreement
	• Milestone in agreement is reached
	  ◦ Check for any deliverables from academic & research organization, status of technology etc
	  ◦ Reminder and request for periodic reports
	  ◦ Receipt of periodic report from licensee; audit and verification
	  ◦ Invoicing
	  ◦ Revenue receipts
	  ◦ Processing for reporting and distribution
	• Repeat from next milestone in agreement
	• Decisions and actions relating to compliance with agreement
	• End of agreement duration

Table 7 (continued) : Selected TTO workflows and key milestones

As one can see above, all workflows will have certain decision points where a decision making authority will need to step in and take a decision on either going ahead or terminating the process, or making choices in the course to take, or making resource investments etc.

The decision-making authorities can be different in different types of organizations – in most cases, the following are the decision authorities:

- Head of the organization, such as Director/ Vice Chancellor or equivalent
- Dean of R&D or equivalent
- A committee
- Head, TTO

Selected important decision points related to patent management:

- Decision to go ahead with first filing of a patent application (Investment: $)
- Decision to file a PCT application (Investment: $$)
- Decision to go ahead with "National" phase filings in selected foreign jurisdictions (Investment: $$$)

Note: The number of $ signs in front of each decision is provided as an indicator of investments involved. Higher the number of $ signs, higher the investments.

The choice of the decision making authority is an important factor that determines the efficiency and effectiveness of institutional processes. Poorly managed organizations suffer from significant delays due to high work load of key decision makers and how they prioritize technology transfer decisions, paralysis due to over analysis, paralysis due to imagined fears and paralysis due to lack of awareness or comfort with the technology transfer discipline.

Selected important decision points related to technology marketing and licensing

- Decision to qualify a lead and investment in efforts to build conviction in the lead
- Decision to go ahead with a NDA/ MTA
- Term Sheet and the proposed deal structure & terms
- Draft Licensing Agreement
- Decision to agree on deal terms; Deal closure
- Decision to take action against licensee for non-payment or breach of agreement
- Decision to take action against an infringer for infringing the technology of an academic/ research organization

In all above cases, the TTO needs to create supporting documents that provide the necessary basis for taking the decision.

2.4 Staffing and training

The choice of the head of the TTO is often critical for success of a TTO.

Ideally, a TTO needs to be led by a professional who has considerable focus on technology commercialization, if not hands-on experience in commercializing technologies. Technology commercialization experience typically includes some technology development experience, experience engaging with IP professionals, experience in concept selling of a technology idea/ product, communicating value propositions, finding interested commercial partners and commercial deal-making experience. Typically such expertise is more often found amongst experienced technology developers who have also commercialized technologies or industrial innovation managers (especially those who have been involved in in-and-out-licensing for companies) or start-up founders of inventive enterprises. Mere academic research excellence or intellectual property practice experience may not be adequate background for leading a TTO.

Section 1.6 of this Handbook discusses all the activities of a typical TTO and proposes how those activities can be further classified into Units (in more mature TTOs). Section 2.1 of this Handbook lists potential organizational structures of TTOs at different stages of maturity including potential roles. The table below lists the training/ skills/ experience that is relevant for each category of activities.

Units	Training/skills/ experience
IP protection & portfolio management: • Awareness, training, enabling policies • Identifying/ sourcing technology assets • IP protection and management • Patent analytics for decision support	• Science, engineering and allied disciplines • IP law & procedures of IP offices • Collaboration agreements • Networks with IP attorneys • Cost management
Valorising technology assets: • Awareness, training, enabling policies • Technology assessment • Technology translation and readiness; Innovation/POC funding	• Technology translation experience • Industry experience • Project management • Grant sourcing & management
Tech marketing and transactions: • Technology assessment • Technology marketing • Advancing a lead closer to deal-making • Technology transfer deal structures/ agreements • Technology valuation • Negotiations and closing a deal • Post-deal contract life cycle management	• Marketing; Communication • Lead development • Networks with tech scouts in industry/ industry leaders; Relationship management • Deal structuring; Licensing; IP law • Valuation • Negotiations • Contract management and enforcement • Revenue management
Venturing & other routes to market: • Awareness, training, enabling policies, clubs • Tech venturing and spinouts; seed funding • Other models of technology commercialization	• Start-up founder experience • Seed investing • Raising investments • Networks with incubators, accelerators, investors • Equity portfolio management

Table 8: Activities/ functions of a TTO and corresponding training/skills/ experience desired to carry out that activity/ function

It is clear from the above table that effective technology transfer requires diverse training, skills and experiences, and hence considerable team work.

Given the diversity of academic and research organizations, their differences in goals, varying degrees of maturity in technology development and innovation management activities, constraints in hiring and remuneration etc as well as a shortage of experienced professionals nationally in the field of technology transfer, it would not be wise to straight-jacket each role and prescribe essential qualifications and experiences for each role.

However, a few relevant academic programs and professional certifications/ accreditations are mentioned in the below table:

Units	Training/skills/ experience
IP protection & portfolio management	Training: • PhD, MTech, MSc and equivalents: Science/ engineering/ medical training preferably with exposure to technology development in dissertations or internships or work experience. • PG Diploma in IPR/ Patent Law: Formal training in IP law and strategy, (OR) LLB/ LLM/ Masters in Business Law: Formal training in law including IP Law and Contract Law Certifications/ accreditations: • Registered Patent Agent Work experience: • IP attorney firms, IP/ Patent Facilitation Centres, Patent analytics consulting firms • IP management in corporates
Valorising technology assets	Work experience: • Hands-on experience in conceptualizing, pitching and executing projects involving technology development, translation and de-risking in industries or start-ups or translational R&D organizations. • CTOs in science and technology based start-ups
Tech marketing and transactions	Training: • PhD, MTech, MSc and equivalents: Science/ engineering/ medical training preferably with exposure to technology development in dissertations or internships or work experience. • MBA or equivalents: Business training with exposure to marketing and sales/ financial modelling and portfolio management/ entrepreneurship. • PG Diploma in IPR/ Patent Law: Formal training in IP law and strategy, (OR) LLB/ LLM/ Masters in Business Law: Formal training in law, including IP Law and Contract Law Certifications/ accreditations: • Registered Technology Transfer Professional • Certified Licensing Professional Work experience: • Fund raising experience; P&L and revenue management responsibilities • Sales and marketing of science and technology based products • Innovation management roles in corporates with in-licensing or out-licensing experiences • Deal structuring, deal-making/ negotiation experiences

Table 9: Selected academic programs and certifications/ accreditations for emerging technology transfer professionals

Units	Training/skills/ experience
Venturing & other routes to market	Training: PhD, MTech, MSc and equivalents: Science/ engineering/ medical training preferably with exposure to technology development in dissertations or internships or work experience. MBA or equivalents: Business training with exposure to marketing and sales/ financial modelling and portfolio management/ entrepreneurship. Certifications/ accreditations: Chartered accountant Work experience: Experience as a start-up founder who has set up company and taken it to at least one round of investment Experience in seed investing and engaging with investor community Experience as incubation manager mentoring start-ups, arranging funds and interacting with investors

Table 9 (continued) : Selected academic programs and certifications/ accreditations for emerging technology transfer professionals

2.5. Planning the finances

Managing the finances of a TTO is quite a challenge! The costs can be high and the direct, immediate financial returns can hard to come by.

It is fact that most TTOs of academic/ research organizations around the world spend more than they earn.

MYTH

TT earnings can substitute grants and contracts

No. Grants and contracts are primary sources of funding research in academic and research organizations. TT earnings have not been able to substitute grants and contracts. The best of global institutions earn only up to 2-5% of their R&D budget.

So, one may ask why academic/ research organizations still fund TTOs? Some reasons are given below:

- TTOs help organizations demonstrate their usefulness to society and economy in many visible ways other than educating the next generation of leaders and workers for society. Gain stakeholder support and considerable funding support (that can often far exceed the direct technology transfer income of these organizations).
- TTOs help organizations attract faculty/ scientists/ students to academic and research organizations who are keen to see their research put to use for the benefit of the people. Having innovators and entrepreneurs working in close association with researchers presents a considerable opportunity for researchers to advance their technologies closer to widespread use with potential societal and financial impact.

- TTOs help organizations increase corporate engagement and thus help bring real-world problems to academic researchers thus adding new dimensions to their academic and research program which not only enrich the research but also bring the training of students closer to real-world situations.
- Technology transfer presents an opportunity for academic and research organizations to create new (albeit relatively smaller and unpredictable but unconstrained) revenue streams for the organization.

In the context of the above reality of how TTOs are financed and managed, a very important skill for the Head of the TTO is to be able to communicate the larger purpose of a TTO to stakeholders inside and outside the organization.

Additionally, to garner their support towards funding activities of the TTOs as well as facilitating the journey of technologies closer to market in many other ways.

On a brighter note, there are noteworthy TTOs who have demonstrated that given adequate time and availability of high-quality "transactable assets", they can raise enough resources to operate TTOs profitably.

The tables 10 and 11 provide a list of outflows and inflows that a typical TTO needs to plan for.

Head	Sub-heads	Comments
Office Establishment Costs	-	One-time outflow
-	Office equipment	-
-	Information resources, reference library	-
-	Custom software, database management systems	-
Office Operating Cost	-	The TTO may need an annual budgetary support for its growth and operations.
-	Staff salaries and related costs, Staff training and certification	Major expense
-	Utilities & Supplies	-
-	Subscriptions • Software • Databases	Renewal of license of software
-	Travel costs	Travel of the TTO Head should be factored for instance - Participation in relevant events
Variable recurring outflows	-	-
-	External services • IP attorneys	Major expense

Table 10: Indicative financial outflows in a typical TTO

Head	Sub-heads	Comments
-	• Patent analytics and decision support • Agreement drafting services • Technology marketing services • Digital marketing services • Litigation services	Major expense
-	Statutory payments including patent application fees and related	Major expense (especially for foreign filings)
-	Interns, temporary staff	-
-	Marketing, lead generation, travel and related	Important head for a vibrant TTO. Often underfunded.
-	Taxes and other payments to the Government	-

Table 10 (continued) : Indicative financial outflows in a typical TTO

Major outflows are staffing costs, external services like IP attorneys, statutory payments related to IP filings especially in foreign jurisdictions. In the early stages, TTOs rely on generous support from parent organizations, grants from local governments/ agencies, and donations from well-wishers before some service income builds up. Income from technology transactions take time to build up. Running royalties and equity returns cannot be relied on for funding operational costs.

Head	Sub-heads	Comments
Income from technology transactions	• Upfront and milestone fees • Running royalties • Option fees	Takes time to build
Income from services and sales	• Income from consulting services • Income from research services • Income from technical/ testing/ analytical services • Income from sale of data/ materials	Can be early sources of inflows
Capital gains	• Sales of securities (shares or other securities) held	As permitted by the law
Reimbursements	• Patent cost reimbursements	

Table 11: Sources of potential inflows for TTOs

Head	Sub-heads	Comments
Income from other assets such as research parks, intangible assets like trademarks etc	· Income from selling rights to any other assets owned or managed by the TTO on behalf of the parent organization	Applicable if TTO is given charge of research parks, other such assets.
Income from legal actions	• Settlements from legal actions taken	This income depends on the quality of IP, ability to track infringements and initiate legal proceedings.
Grants support	• Establishment or operational grants that offset certain costs	Grants may be available from local governments that aim to improve research commercialization outcomes.
Income from reserves/ corpus/ endowments	• Income from deploying reserves, corpus or endowments.	Some TTOs have built reserves from lucky windfalls. Some TTOs can tap their alumni and other well-wishers to raise endowments or build a corpus.

Table 11 (continued) : Sources of potential inflows for TTOs

It is interesting to note that one can operate a TTO at widely varying scales and budgets depending upon the needs of the organization. This also means that an organization can start with a nascent TTO and basic skeletal operations and then scale up operations progressively as the volume of inventions and transactions increase.

An academic/ research organization can start with a nascent TTO and basic skeletal operations and then scale up operations progressively as the volume of inventions and transactions increase.

2.6. Impact and performance tracking and processing

The raison d'être for TTOs is impact! Tracking, documenting and reporting impact for the academic and research organizations, and their stakeholders (especially, local governments and communities, funding agencies, charities/ foundations, organization's community of students/ staff/ faculty and alumni, local industry etc) becomes a mission critical activity for every TTO.

Leading TTOs publish annual reports which include not only a summary of facts and data but also attractive and easy-to-read stories of impact creation.

For examples, please visit the Technology Transfer Online Manual at https://manual.techtransfer.online

The Association of Technology Managers of USA has standardized a reporting infographic template (called informally as the "Technology Transfer Wheel") that is also used by several US universities in their reporting. This is reproduced here in the Figure 3 for reference.

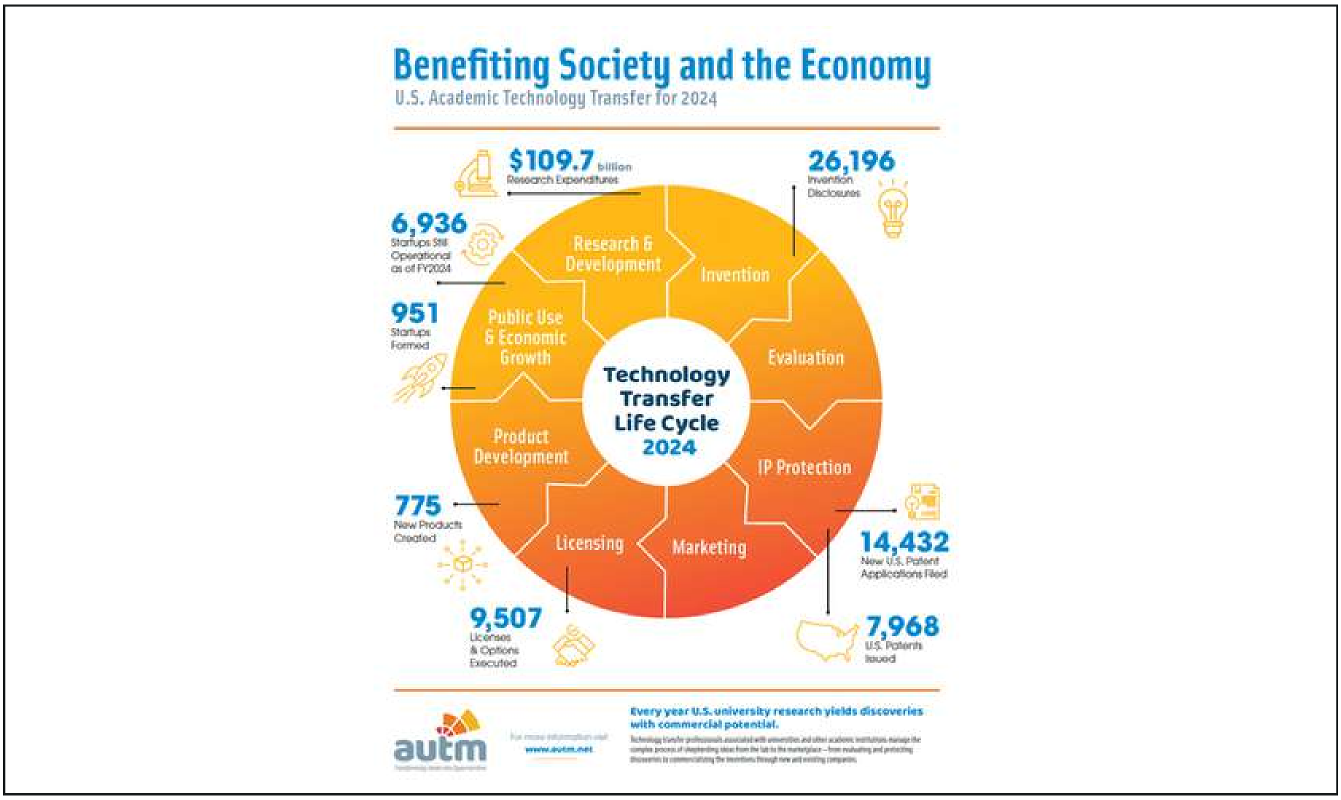

Figure 3: The "Technology Transfer Wheel"
(Ref: https://autm.net/surveys-and-tools/tech-transfer-infographic)

Academic/ research organizations can also use the metrics that have been used by the Ministry of Education, Government of India in the NIRF rankings or the Innovation Excellence Indicators developed by CTIER for the Office of PSA or the metrics used by WIPO in curating the annual list of Global Innovation Index.

Table 12 provides a list of parameters that academic and research organizations may wish to track, document and report.

Category	Metric
Inputs	Research expenditure of academic/ research organization Number of faculty Number of PhD students Number of students in UG and PG programs
Assets	Number of unique inventors amongst faculty and students Number of know-how packages available Number of patents approved Number of other IP registered and approved Special useful collections of data/ materials/ bio-samples available Other unique capabilities of interest to industry

Table 12: Metrics that TTOs can track
(Metrics in bold are those also used by the AUTM Technology Wheel)

Category	Metric
Outputs (Shorter-term)	• Number of invention disclosures received • Number of unique patents families filed • Number of PCT applications filed • Number of licensing and options agreements signed (Number of deals closed)
Outcomes (Mid-term)	• Number of patents approved • Earnings from technology licensing deals for the academic/ research organization • Cumulative investments attracted in advancing the licensed technology in terms R&D, clinical/ field trials, manufacturing facilities etc • Number of new products created • Number of start-ups formed
Impact (Longer term metric; has diffusional effects that cannot be entirely and directly attributed to the research organization; harder to measure)	• Marquee success stories of technology or alumni founders • Cumulative turnover of products made using licensed technology • Cumulative number of lives impacted by products made using licensed technology • Cumulative number of start-ups formed who are still operational after 5 years • Cumulative risk capital attracted by start-ups formed • Cumulative turnover of start-ups formed • Tax contributions of start-ups formed • Cumulative jobs created by start-ups formed

Table 12 (continued) : Metrics that TTOs can track
(Metrics in bold are those also used by the AUTM Technology Wheel)

While the above metrics are all preferable to measure and track, TTOs may choose to focus on a few that can be measured efficiently. Despite the best efforts, not all aspects of impact can be captured via measurable metrics. It is in this context, that impact reports of TTOs need to include stories and case studies narrating intangible or difficult to quantify impact. It is absolutely critical to highlight marquee success stories and additional indicators of the vibrancy of the innovation ecosystem hosted by the academic/research organization and leveraged/ energized by the TTO of that organization.

For example, it is more important for Stanford University to showcase the impact of its pioneering recombinant DNA technology or the Google PageRank methodology and its impact on society than to focus on its technology transfer earnings. For example, see the Stanford OTL's report: https://otl.stanford.edu/sites/g/files/sbiybj16766/files/media/file/stanford_otl_50th_anniversary_annual_report_fy2020.pdf

"The most important task of a Technology Transfer Professional is to communicate effectively — the benefits of the technology to potential licensees, the benefits of tech transfer to the research institutions and the impact of tech transfer to the funders, government and all stakeholders"

Mr. John Fraser on how important effective communication is to the tech transfer profession. "

2.7. Case studies of the Indian TTOs

The Evolution of the Technology Transfer Office at CSIR-NCL : A Case Study

The early years of a TTO

India's experience in technology transfer has been deeply shaped by the evolution of the Council of Scientific and Industrial Research (CSIR) and, within it, the National Chemical Laboratory (NCL). Founded in the 1940s to support wartime material innovation, CSIR housed a Patent Unit as early as 1942; a pioneering step toward institutional management of intellectual property. In the decades following independence, the organization became the backbone of India's research-to-industry interface. The 1950s and 1960s were devoted to building scientific capacity and developing indigenous substitutes for imported technologies. When shortages of food and medicines intensified, the 1972 Patent Act amendment removed product patents in food, agrochemicals, and pharmaceuticals, encouraging domestic production and laying the foundation for applied industrial research.

Creation of a centralized technology marketing company

Through the 1970s and 1980s, NCL emerged as a leader in import substitution, developing chemical processes for agrochemicals and polymers while expanding into catalytic and high-technology domains. At the time, the National Research and Development Corporation (NRDC) acted as the central licensing agency for CSIR, but by the early 1980s laboratories were encouraged to create their own internal technology-transfer mechanisms. Formal guidelines for technology transfer were introduced, and NCL began institutionalising a business-facing structure that would later become one of India's earliest examples of a technology-transfer office. NCL developed and commercialized a very large number of technologies to the Indian chemical industry in 1970s and 1980s.

Return to a decentralized model of a TTO for greater focus and alignment:

A major shift occurred in 1987 when the Abid Hussain Committee recommended that CSIR generate one-third of its revenue from external sources. This self-reliance target transformed the culture of India's public R&D system. NCL responded by creating a Project Planning and Business Development Unit to help scientists link their discoveries with market needs.

Acting as a commercial agent, the unit supplied market and techno-economic intelligence, connected industrial clients with laboratory divisions, and evaluated projects before they were funded or licensed. This approach signaled a move from curiosity-driven to demand-driven research, embedding business reasoning within a scientific organization. An internal review of projects exposed systemic challenges such as weak market assessments, limited techno-commercial evaluation, and partnerships with industries that lacked financial or marketing strength. Many technologies were pursued for scientific prestige rather than market utility. NCL's response was to develop a structured evaluation framework that examined market size, competition, scalability, freedom to operate, and regulatory constraints before commercialization. This discipline ensured to some extent that the laboratory invested in technologies with clearer application potential.

Gearing up for global technology marketing

By the 1990s, NCL had reorganized its interface with industry under a Research Planning and Business Development Division, which unified functions for business development, intellectual-property management, legal affairs, communications, and analytical services. Top management endorsement and internal marketing became essential, helping overcome resistance to commercialization within scientific teams.

The laboratory's philosophy evolved toward practical wisdom captured in its own "lessons learned": know your customer, think like a technical businessperson, communicate at the right level, be open about risk and cost, and never oversell. These principles, now echoed in training programs across Indian TTOs, gave NCL a durable foundation for professional technology management. In the 1990s, NCL saw its first international technology transfer and several R&D programs with global industry leaders.

From classical technology transfer to partnerships and entrepreneurship

In early 2000, there was an increasing realization that:

- Increasingly, technology development and de-risking will require deeper, closer and longer partnerships with industry that leverages the intellectual strengths of NCL scientists and the speed and efficiency of the private sector.
- NCL will increasingly work with entrepreneurial high-growth entities (start-ups) and not just established firms. And for this, NCL will need to build and nurture an entrepreneurial ecosystem. The focus and entrepreneurial energies and ambitions of early stage start-ups can be a tremendous asset for researchers interested in research commercialization.
- NCL will need to participate in and drive product innovations and not just limit itself to process innovations.
- NCL will need explore and deploy new age IP management and technology commercialization models and techniques that go beyond the classical technology licensing models.

It was in this context that NCL created. A new resource center in 2007 called NCL Innovations to support the Business Development Division. The goal of NCL Innovations was to conceptualize and build a larger and richer innovation ecosystem that will offer many more delivery routes for taking technology to market. The Intellectual Property Group within NCL Innovations brought modern processes for IP portfolio management, widened the inventor pool and set up the foundations for NCL scaling the number of patent filings more than 10 folds between 2007 to 2013. NCL was filing 30-40% of CSIR 's patent filings.

The team inducted IP professionals and engaged external professional services for patent analytics and decision support. The Innovation Management Group within NCL Innovations inducted professionals with management training to drive technology marketing, technology assessment and deal structuring. This group also conceptualized and implemented new mechanisms to promote spinouts and faculty entrepreneurship and public-private partnership models. The Innovation Management Group also helped spinout start-up companies based on NCL capabilities. The NCL Innovation Park Group focused on developing a conducive ecosystem for start-ups and other innovators leveraging the NCL mind space to advance their own ideas. The most successful effort in the NCL Innovation Park became the Venture Center – a leading inventive enterprises incubator in India that has mentored more than 1000 start-up teams and has physically hosted more than 300 resident start-ups in the last 18 years.

The evolution of a TTO

NCL's technology transfer functions have transformed over the years with changing National and global trends. It has seen the following phases:

- A patent cell coordinating patent filings and interfacing with technology marketing agencies
- A facilitator of industrial interactions and marketing of research capabilities
- Global deal maker and champion of "external cash flows"
- Strategic manager of a large IP portfolio
- Champion new routes to market
- Innovation ecosystem builder
- Champion for entrepreneurship and spinouts

NCL's technology transfer office experience points to the need for TTOs to continuously reinvent themselves as internal and external environments change.

Centre for Technology Acquisition and Transfer at ARCI:

R&D organization with technology translation as primary mandate:

The International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI), located in Hyderabad, India, is an autonomous research and development center under the Department of Science and Technology (DST), Government of India.

Established in 1997, ARCI focuses on the development, demonstration, and commercialization of advanced materials and processing technologies. Its key research areas include nanomaterials, ceramics, surface engineering, and solar energy materials. ARCI collaborates with industries, academic institutions, and international organizations to translate laboratory innovations into viable technologies, supporting India's growth in advanced materials and manufacturing sectors through applied research and technology transfer.

Building up an IP portfolio and technology transfer track record

ARCI is a relatively young and focused research organization with a relatively smaller scientist team strength. Technology transfer and translation is a key mandate. In the early years, ARCI focused on developing technology capabilities critical to the strategic industries, building indigenous capabilities and import substitution. The focus on patent filings was low. In the last decade, ARCI has increased its emphasis on patent filings with the patent portfolio now reaching more than 125 patents filed.

ARCI is organized into R&D Centers and Technical Centers. One of the Technical Centers is called the Center for Technology Acquisition and Transfer (CTAT). It is led by a scientist with engineering and technology transfer training. The team is a small team of 3-5 members. CTAT is responsible for facilitating all industry collaborations and projects, intellectual property management, technology marketing and transfer as well as receivables management. The team has had considerable success in technology transfer to industry – as their website says, "ARCI has transferred technologies to more than 46 companies and developed about 250 technological solutions for industrial and strategic sectors."

A recipe for emerging TTOs

As a relatively smaller research organization and smaller TTO, ARCI has shown good technology transfer results due to a) an institutional focus on technology development and translation driven by institutional leaders, b) close interaction with industry and strategic sectors, c) willingness to adopt technology transfer practices from other institutions in upgrading their practices and d) creating enabling policies.

More information at: https://www.arci.res.in/coe-centre-for-technology-acquisition-transfer

Selected Indian TTOs

TTOs in Indian academic institutions:

- IIT Bombay (IRCC): https://rnd.iitb.ac.in
- IIT Delhi (FITT- an independent Society): https://fitt-iitd.in/web/home
- IIT Madras: https://ipm.icsr.in/ipm/
- IIT Kanpur (IPR Cell): https://iitk.ac.in/ipr/
- IISc Bangalore (IPTeL): https://iptel.iisc.ac.in
- BITS Pilani (TTO): https://www.bits-pilani.ac.in/research/tto/

TTOs in research organizations:

- Agrinnovate India (For profit company, PSU): https://www.agrinnovateindia.com/
- DRDO (DIITM): https://www.govtdrdo.com/headquarter-directorates/industry-interface-technology-management.html
- ISRO's New Space India Limited: https://www.nsilindia.co.in/technology-transfer
- DST-ARCI's Centre for Technology Acquisition and Transfer: https://www.arci.res.in/coe-centre-for-technology-acquisition-transfer

Regional Technology Transfer Organizations:

- NBM's RTTO network: https://www.birac.nic.in/desc_rtto.php
- Venture Center's TechEx.in: https://www.techex.in

Technology marketing companies serving multiple organizations:

- NRDC (Non-profit, PSU) : https://nrdcindia.com
- BCIL (For profit company): https://www.biotech.co.in

2.8. Case studies of the International TTOs

Florida State University : A Technology Transfer Office Case Study in Turning Research into Real-World Impact

The beginnings of a TTO

Florida State University's (FSU) Technology Transfer Office (TTO) was established in 1996 with a bold vision; to turn the university's strong research capabilities into real-world innovations that could benefit both people and the economy. At the time, FSU had a growing research base but lacked a structured system to move discoveries beyond the laboratory. The creation of the TTO marked a shift from a traditional academic focus to a forward-looking, entrepreneurial approach where research could meet market needs.

From the start, FSU's TTO adopted a clear and systematic model. It encouraged faculty and researchers to disclose their inventions, assessed each for commercial potential, and sought patent protection where suitable. These patents became the foundation for licensing agreements and start-up creation. To help bridge the often difficult "valley of death" between research and commercialization, FSU introduced the "GAP" funding program designed to support proof-of-concept development and attract investor interest, a move that eventually delivered impressive results!

Strengthening the IP portfolio and growing innovation culture

Between 1996 and 2012, invention disclosures increased from just 7 to 62 per year, patent applications rose from 17 to 84, and issued patents rose from 7 to 28. This steady rise reflected a growing innovation culture within the university, where faculty participation and industry partnerships became increasingly common.

A breakthrough that energizes tech transfer operations

A defining success came with the licensing of Taxol, a cancer treatment technology discovered at FSU. The patented drug went on to help more than two million women worldwide in the first five years after market launch, a powerful demonstration of how academic research, backed by a strong patent strategy, can create life-changing global impact. The Taxol case also brought major financial returns that fueled the university's technology programs. By 2012, cumulative non-Taxol royalties had reached \$19.2 million, with an additional \$46.8 million earned
from external R&D contracts bringing the total net benefit to over \$30 million.

People and organization culture are important

However, the TTO's growth story was not just about numbers. FSU learned early that successful technology transfer depends as much on people and culture as it does on patents. Building awareness among faculty, recognizing innovators, and encouraging collaboration proved essential. The GAP fund played a critical role in de-risking inventions, while diversification beyond traditional patents into software, creative works, and digital media expanded FSU's commercialization reach. A proactive business development team strengthened ties with industry partners, marketing innovations instead of waiting for companies to approach the university.

Importance of well-defined processes

For universities and other TTOs, FSU's model highlights the importance of a well-defined process that links invention disclosure to IP protection, funding, licensing, and start-up creation. Investing in early-stage proof-of-concept support greatly improves commercialization success. Measuring performance should go beyond financial returns to include start-up formation, job creation, and regional economic growth. Public research organizations can adapt this approach by streamlining their tech transfer systems and promoting IP literacy across disciplines. Meanwhile, industry partners benefit most from collaborating with universities that have transparent IP policies and effective commercialization mechanisms in place.

From an administrative activity to a movement

Ultimately, FSU's journey is a story of transformation. What began as an administrative effort to manage patents evolved into a dynamic ecosystem that fuels entrepreneurship and regional development. The Taxol breakthrough became more than a single success; it symbolized how intellectual property can translate academic research into tangible social value. Over 36 start-ups have since emerged from FSU's innovation pipeline, collectively raising over $35 million in equity and revenue.

Today, FSU's TTO stands as a model for how public universities can align research excellence with real-world impact.
Its experience demonstrates a simple truth: when patents are guided by purpose, innovation transcends the lab, creating benefits that reach society, industry, and the economy at large.

Boston University Case Study

Before professional technology transfer operations

Boston University (BU), founded in 1839, has evolved into one of America's leading research universities, renowned for its ability to blend academic excellence with innovation and entrepreneurship. With more than 37,000 students, 4,500 faculty members, and over $700 million in annual research funding, BU's transformation into a powerhouse of technology transfer has been shaped by a long history of experimentation, adaptation, and learning.

The roots of BU's engagement with innovation trace back to 1876 when Professor Alexander Graham Bell, a member of its faculty, patented the telephone. The university, however, earned nothing from this world-changing invention because it lacked a patent policy; a reflection of a time when universities were primarily teaching institutions. That missed opportunity later inspired BU to rethink how academic research could create societal and economic value.

In the 1950s, BU played a pivotal role in the creation of Itek Corporation, one of Massachusetts's early high-tech ventures. Through its Applied Physics Laboratory, BU contributed talent and expertise to Itek's success and, in return, received company stock. Although the university sold its shares early, missing the post-IPO surge, the experience taught BU a critical lesson about the potential of research equity. Determined to avoid similar missed opportunities, BU's leadership took decisive steps to professionalize technology transfer.

Promoting start-ups and industrial partnerships

In 1975, BU established the Community Technology Fund (CTF), one of the earliest university-backed venture funds in the United States. Under the leadership of Walter Levison and later patent attorney Larry Gilbert, BU combined venture funding with IP management and translational research support. By the 1980s, BU had launched initiatives such as the Health Policy Institute and the Photonics Center, both of which became incubators for spin-out companies and industry partnerships.
The creation of BioSquare, a biomedical research park, and collaboration with the Fraunhofer Center for applied research demonstrated BU's ability to link academia with industry in a sustained, structured manner.

Consolidating technology commercialization activities

In 2005, BU consolidated its innovation activities under a unified Office of Technology Development (OTD). The office assumed responsibility for managing incubator operations, mentoring inventors, and administering early-stage seed funding programs. The Ignition Fund, which evolved from the university's early translational research initiatives, became a cornerstone of this strategy, awarding roughly $300,000 annually to help bridge the gap between laboratory discovery and commercial validation. Support from the Wallace H. Coulter Foundation expanded BU's capacity in medical-device innovation, creating a $10 million endowment to ensure long-term sustainability.

Maturing as a technology transfer office and looking back at the journey

By 2023, the TTO reported 95 invention disclosures, 87 new patent applications, 36 issued U.S. patents, 31 licenses and options, and three start-ups, generating $3.4 million in income against $2.1 million in patent expenditures. Its staff had grown from 2.5 full-time employees in the mid-1990s to a team of 13 professionals managing an ever-expanding IP portfolio.

The Boston University model illustrates that successful technology transfer depends not only on patents or revenue but also on culture, communication, and collaboration. The decision to close the Community Technology Fund and reinvest its returns into proof-of-concept programs reflected strategic agility, aligning BU's approach with Boston's mature venture ecosystem.

By emphasizing mentorship, student-analyst programs, and translational grants, BU turned technology transfer into both an educational and economic mission.

From Alexander Graham Bell's telephone to today's thriving innovation ecosystem, BU's journey captures the essence of how universities can evolve from centers of teaching to engines of technological and societal transformation. Its experience demonstrates that when academic institutions build adaptable, forward-looking technology-transfer systems, research moves beyond the lab to create real-world impact—one innovation at a time.

Learning from Leading International TTOs

The top performing TTOs of the world are also often backed by a powerful R&D engine and large research budgets. While their success is worth emulating, they may not be the best role models for nascent/ emerging TTOs. Nonetheless, we recommend that Technology Transfer Professionals learn from their processes and impact stories. Here are a few examples:

Stanford University's Office of Technology Licensing :

- About OTL: https://otl.stanford.edu/about/about-otl
- Annual Reports: https://otl.stanford.edu/about/annual-reports
- A Half a Century of Pioneering Innovation: https://otl.stanford.edu/sites/g/files/sbiybj16766/files/media/file/stanford_otl_50th_anniversary_annual_report_fy2020.pdf

University of Wisconsin-Madison's Wisconsin Alumni Research Foundation (one of the oldest TTOs in the world celebrating 100 years in 2025) :

- About WARF: https://www.warf.org/about-warf/
- History: https://www.warf.org/about-warf/history/
- WARF at 100: https://www.warf.org/centennial/

Massachusetts Institute of Technology's Technology Licensing Office :

- About TLO: https://tlo.mit.edu/about
- Annual Reports: https://tlo.mit.edu/about/annual-reports
- How MIT promotes entrepreneurship: https://www.kauffman.org/wp-content/uploads/2009/02/mit_impact_full_report.pdf

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UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION
Progress by innovation

3

Section 3 :

3.1. Creating and identifying technology assets

3.2. IP protection and management

3.3. Patent analytics for decision support

3.4. Technology translation and readiness

3.5. Technology assessment

3.6 Technology marketing and advancing a lead closer to deal-making

3.7. Technology transfer deal structures/ agreements, negotiations and closing a deal

3.8. Technology valuation

3.9. Post-deal contract life cycle management

9 Key activities undertaken by a TTO

1. Creating and identifying technology assets
Emerging TTOs: Build awareness, train stakeholders, and support tech development projects.
Established TTOs: Scout technologies from ongoing research and engage entrepreneurial faculty.

2. IP protection and management
Effective IP protection is key to attracting investors and licensees. TTOs typically outsource IP management, though some maintain in-house capability.

3. Patent analytics for decision support
Patent analytics enable TTOs to evaluate a technology's patentability & freedom to operate.

4. Technology translation and readiness
TTOs should be aware of TRLs, ARLs and communicate these when required for the technologies that they are marketing

5. Technology assessment
Technology assessment helps a TTO evaluate a technology's potential, define its value proposition, guide investment decisions in IP and development, and shape effective commercialization strategies.

6. Technology marketing and advancing a lead closer to deal-making
Targeted marketing efforts to prospects identified through industry experts in your networks often yields better results

7. Technology transfer deal structures/ agreements, negotiations and closing a deal
Essentially deal structures should be designed by TTOs to head to a deal closure and have enough scope for flexibility to allow a closure and not a stand-off

8. Technology valuation
For early-stage academic technologies, production cost is largely irrelevant to valuation, as it often follows extensive exploratory research. It is difficult to value early stage technologies. But valuation exercises point to key value driver to support the negotiation team.

9. Post-deal contract life cycle management
Post-agreement monitoring is vital for TTOs to collect licensing payments and continued institutional support for the commercialization team.

Figure 4: 9 Key activities undertaken by a TTO

Understanding the activities undertaken by the TTO

This section discusses the most important and common activities undertaken by a TTO from sourcing and protecting inventions, marketing them to potential partners and finalizing partnerships via agreements.

3.1. Creating and identifying technology assets

The first task in front of a TTO is to survey and identify technology assets in the academic/ research organization that it can market and transact in. Appendix 1 describes the various transactable assets that a TTO may wish to identify.

In nascent academic/ research organizations or those newly transforming into research universities, the volume or track record of research may be low. In which case, a TTO may focus on building awareness, training faculty and students, and helping arrange resources for technology development projects so as to develop an invention culture in the organization, increase the inventive capacity and technology output of the organization. The awareness and training can focus on such themes as:

- Understanding the technology development and translation process,
- Need identification and problem definitions,
- Ideation and invention,
- Intellectual property awareness,
- Customer discovery and
- New venture creation and entrepreneurship

In mature organizations with a history of R&D and technology development, a TTO may focus on increasing the number of inventions being reported/ disclosed by scouting for technology ideas amongst the various research projects in progress and seeking out inventors with a passion and commitment towards for technology commercialization and entrepreneurship.

Scouting for technology ideas may involve TTO staff visiting and meeting with each research group, scanning PhD projects, scanning internal presentations and poster sessions, and alerting senior research managers to direct colleagues to the TTO. In certain cases, TTOs can use innovation challenges and funding calls by funding agencies to mobilize teams ideating to solve specific problems. Mature organizations also need continuous efforts in awareness and training since most academic and research organizations see a continuous flux of students and project staff.

It is recommended that TTOs build and maintain the following internal databases:

- Compilation of technology capabilities in the organization categorized by
    - Technology sectors (like for example, biotechnology, battery technology)
    - Industry sector (like, biopharmaceuticals, mobility & EVs)
- Database of technologies licensed and industrial research projects undertaken by research groups (this is primarily to know research groups that may be more interested in engaging with the TTO)
- Database of patents
- Database of special facilities, capabilities, collections etc in the organization

3.2. IP protection and management

Effective IP protection is often a necessary pre-requisite for commercializing several technologies which require considerable investment in development over many years. Without effective IP protection, a technology idea may not receive interest from potential licensees or investors who might fear that their investments may not have the benefit of competitive advantage that IP rights may provide.

It is in this context that most TTOs operate a unit dedicated to receiving and processing new inventions. The IP protection and management activities usually include:

- Serving as a receiving house for invention disclosures and operating an "invention disclosure workflow" described in Section 2.6
- Understanding, documenting and if required, creating additional documentation to clarify ownership of the intellectual property
- Engage external (or internal) services relating to IP filing and prosecution, patent analytics and other such services
- Manage the IP portfolio of the organization with a focus on quantity, quality of protection and coverage, compliance, strategic synergies and cost management
- Ensure compliance to the laws including the Biodiversity Act
- Implement the IP Policy of the organization

Usually TTOs tend to outsource IP drafting, filing and prosecution activities to professional IP attorney firms. A few TTOs maintain in-house professionals to draft, file and prosecute intellectual property.

The following are a few best practices to follow:

- It is vital that the invention disclosure workflow operate efficiently so that inventors do not hesitate submitting invention disclosures due to a fear of delays in publishing their results. It is advised that the unit charged with IP protection and management track and set targets for the time taken from invention disclosure to first filing of a patent application.
- Ensuring clarity of ownership is an important but often overlooked activity in many TTOs in India. This needs special attention especially when involving visiting scientists or collaborations or sponsored projects. Simplicity and clarity in ownership rights is a large factor in successful licensing at a later stage.
- It is advisable that the decision making process for patent filings is efficient and transparent. Carrying out a preliminary patentability assessment can be useful in shaping the decision and next steps.
- In certain institutions, the inventors are expected to arrange funds for IP filing and prosecution costs. This is not a healthy practice. If the organization owns the IP, the organization should arrange the funds for the IP filing and prosecution. This also ensures that the inventors do not hesitate submitting invention disclosures.

3.3. Patent analytics for decision support

Patent analytics plays an important role in supporting decisions of a TTO and commercialization of a technology irrespective of whether the TTO intends to file a patent or not to protect certain aspects of the technology.

Patent analytics help provide information to support the following important questions that a TTO may have to ask:

- Is there a blocking patent by somebody else that prevents the technology under evaluation from being commercially practiced? Note: This question is relevant whether the TTO intends to file a patent or not for select aspects of the technology under evaluation.
- Will the TTO be able to secure a patent for the invention? Will the patent infringe any other active patents?

- Is the patent or patent portfolio core/ relevant to the performance of a technology? Are the claims well written and strong enough to provide a licensee/investor adequate and defendable protection from competitors?
- Which companies could be potential collaborators/ licensees for the patent?
- Is the ownership structure (and thus decision making for transactions) clear, simple and amenable to predictable transfer of rights?

The following table lists a few popular patent analytics reports and the question that the report addresses:

Patent analytics report	Typical question being addressed
Freedom to Operate/Practice (FTO/ FTP) assessments	Can I practice my know-how freely in Region X?
Patentability assessment	Is the invention patentable under the law of Region X?
Patent landscape	What all is being/has been patented by whom in this domain?
White space analysis	Are there gaps in patent coverage in this topic?
Infringement assessment	Is anybody else's know-how infringing claims protected by my patent claim set? OR Is my patent claim set infringing anybody else's patent claim set?
Citation analysis	How often is a patent being cited and by whom? Is this patent "important"?
Competition assessment	Who all are competing in this space and what is each party's strength/weakness?
State-of-art report	What all has been done (and protected) on this topic and what is current leading edge of the technology?
Portfolio analysis	How does our patent portfolio look like along various axes (regional coverage, age, nature of claims, strength of claims, citation strength, industry where relevant, subject etc)? Is it aligned with our IP/ innovation management strategy?
IP audit	Which of our patents in our portfolio can be retained/abandoned/ allowed to lapse/ sold etc with the goal of optimization for benefit/ cost ratio?
IP due diligence	Does the target (from the perspective of a licensee or investee) patent portfolio relevant, have clear ownership title, have any risks or encumbrances, have any ongoing lawsuits or oppositions, have any uncertainties with regards to grant or revocation etc?

Table 13: Typical patent analytics reports used by TTOs

In practice, creating meaningful and high-quality patent analytics reports is expensive and requires considerable skill. It is in this context that TTOs should optimize their use of patent analytics to suit their budgets. Some best practices are provided below:

- It is a good idea to carry out a patentability assessment before the filing of complete specifications. The insights can be used to modify claim strategy.

- FTO/ FTP reports can be done by the licensor prior to entering a licensing negotiation. This would be for building confidence within the licensor's negotiation team. However, most non-profit licensors' will not provide assurances on FTO/FTP to licensee.
- Patent landscapes, white space analysis, competition analysis and state of art reports are usually done early at the start of a technology development project. Since this needs to be done at regular intervals, organizations will benefit from R&D teams being trained in carrying out these reports themselves. In a start-up environment, CTOs would be expected to be aware of the technology trends in their field at all times.
- TTOs would benefit from an annual audit of their patent/IP portfolio. IP portfolio audits essentially carry out an assessment of every patent document in a portfolio for:
    - The legal status of the patent (pending or granted), chances of a grant, strength of protection, coverage in terms of scope, available life and costs involved.
    - The status of the technology and the availability of capabilities to support licensees especially in the context of emerging competing technologies, changing commercial viability, continued availability of key inventors and important institutional research capabilities in the research organization.
    - The licensing status or likelihood of licensing or assessment of market/ industry realities.
    - An assessment of cost to potential future benefit that often has to be assessed in view of emerging trends and future scenarios (which can be difficult to predict and may need considerable foresight from the TTO team).
- Savvy licensees/ investors carry out patent/ IP due diligence prior to entering into a license agreement or investment agreement. Licensors or IP-driven start-ups may benefit from carrying out an internal patent/ IP due diligence before entering into a licensing/ investment negotiation so that they are not surprised by the other side during negotiations.

3.4. Technology translation and readiness

Section 1.3 has described the journey of a technology from a lab to market in considerable detail. Recognizing this multi-step process of translating technologies, the need to track the progress of technology development and de-risking, and the need to define roles and handover points for large scale collaborations, leading technology development organizations (for ex, NASA) & innovation funders (for ex, BIRAC) have relied on scales called "Technology Readiness Levels" or TRLs and its various variations. Since the stages and time scales of technology development in different industries are different, one has to modify these scales for different industrial sectors.A representative TRL scale is shown in the figure below.

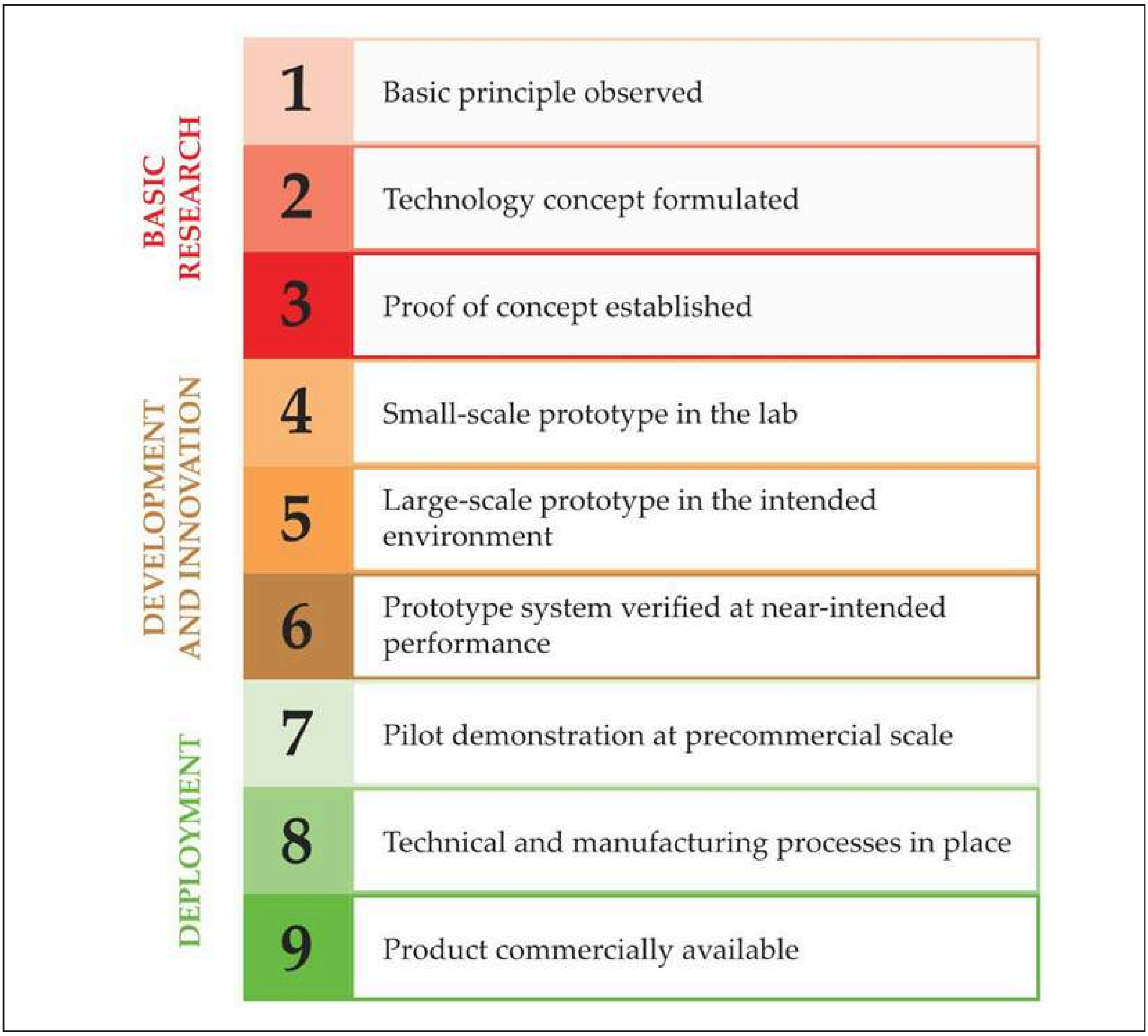


Figure 5: A representative Technology Readiness Level (TRL) scale
Ref: https://physicstoday.aip.org/features/the-road-from-academia-to-entrepreneurship

TTOs should be aware of TRLs and communicate these when required for the technologies that they are marketing. Generally, most technologies from academic and research organizations are in the range TRL 1- TRL4. Some technology development-focused research organizations will advance select technologies to much higher levels of TRL themselves or with partners.

However, one must note that technologies can be licensed at almost any stage of the TRL scale. It is a common belief that TRLs need to be at advanced stages to industry to show interest in licensing; that is true but only for potential licensees like MSMEs and companies in slow moving sectors with very limited in-house abilities to carry out technology de-risking. For breakthrough or foundational technologies and in sectors where the licensee is operating in a fast moving technology area, licensees are likely to approach technology providers early to secure rights before others take it and also aim to put their greater corporate efficiencies and speed to use in accelerating the further development of the technology rather than rely on the academic/ research organization. This is also seen in the case of licensing to start-ups.

MYTH

Technology always needs to be at high TRL level to be licensed

No. Not true for breakthrough or foundational technologies and in sectors where the licensee is operating in a fast-moving technology area. Not true where industry partner is convinced about the technology and has the internal capability and speed to expedite development. Not true for many cases of licensing to start-ups where technology foresight and early licensing by start-up founders is key to start-ups raising risk capital.

In recent decades, several prominent TTOs have set up in-house Proof-of-Concept funds or Centers (for example, the Deshpande Center at MIT, the Rothenberg Innovation Initiative at Caltech, Wadhwani Innovation and Translation Centre at IIT Bombay that fund the advancement of the technology further down the TRL scale. Here again an understanding of TRL scales can prove useful.

TCRM Matrix and Adoption Readiness Level

A variation called the TCRM Matrix on how TRL can be integrated with a Commercialization Readiness Levels has also been proposed by the Niti Aayog (Ref: https://www.niti.gov.in/sites/default/files/2023-07/TCRM-Matrix-Framework-FAD3.pdf).

The US Department of Energy uses a scale called the Adoption Readiness Level along with the TRL in order to assess the readiness for uptake or adoption by the private sector. For this purpose, a risk assessment is done spanning 17 parameters across four main areas –

- Strength of the value proposition,
- Market acceptance,
- Resource maturity, and
- License to risk.
- (Ref: https://www.energy.gov/sites/default/files/2023-03/Commercial%20Adoption%20Readiness%20Assessment%20Tool%20%28CARAT%29_030323.pdf)

The FLCTD project of UNIDO-BEE-GEF has successfully used the Adoption Readiness Scale (ARL) along with TRLs in assessing technologies and their readiness for deployment!

3.5. Technology assessment

Technology assessment is a foundation skill of TTO. TTOs have to build in-house capabilities for quickly assessing technologies for commercialization potential. Occasionally, technology assessments can be outsourced to trusted and experienced partners in parts or full. University of Texas, Austin-based IC2 has pioneered a Technology Assessment format called the QuickLook® Report. Dr Ashley Stevens has designed a format called the FirstLook Report. A modified version of this is used by TechEx.in at Venture Center. A copy of this format is available online via the Technology Transfer Online Manual at https://manual.techtransfer.online.

These technology assessments serve the following purposes:

- Create the basis for investment decisions by the organization in advancing the technology or in IP protection (especially foreign filings which are very expensive)
- Clearly identify and articulate the value proposition of the technology offering in comparison to competing technologies. This is one of the most important activities that a TTO has to do.
- Have clarity and direction for the commercialization strategy

The following table describes key aspects of a technology assessment.

Component	Questions addressed
Understanding the invention	• What is the full scope of the invention? • What are the key inventive features? • How does it compare with alternative technologies? • Why is the invention important?
Product vision	• What is the envisaged product that the invention makes possible? • Who will be potential customers for envisaged product? • What are the features that the product will have including especially those that highlight the features that the invention makes possible? • What are the closest competing solutions serving the purpose for a potential customer?
Value proposition analysis	• What is the unique value (compared to alternatives) the technology creates for the licensee? • What is the unique value (compared to alternatives) the product creates for the customer segment? • How will commercial value be created from the technology? Are the business models clear?
Market opportunity	• Who are the potential customers of the product? • How big is the market? How is it distributed/ segmented? How is it growing? • What is the price point of the product?
Industry and competitive analysis	• How does the industry landscape of other suppliers of the product/ competing solutions look like? • What are the barriers to entry?
Strength of the intellectual property	• Is the invention patentable? • Are the claims strong in terms of coverage of scope and enforceability? • What is the geographical coverage ?

Table 14: Key components of a technology assessment framework

Component	Questions addressed
Technology readiness and pathway	• What is the current level of technology readiness? • What is the evidence that has already been created to support claims of workability, superiority etc? • What is the journey to market? What are costs, timelines and risks?
Risks	• Do you have freedom to operate? • Are there any risks associated with key raw materials, ingredients, components etc? • Are there any complementing know-how needs for commercialization? • Are there any risks associated with quantum of investments needed? • Are there any extra-ordinary regulatory risks or barriers?
Final recommendations	• Strategy for investments in patents • Strategy for marketing and lead generation • Strategy for commercialization pathway such as licensing to large company, new venture creation etc

Table 14 (continued) : Key components of a technology assessment framework

These technology assessments are done using various tools including:

- Secondary research using online research tools. This has been greatly simplified and made relatively inexpensive on the internet by Gen AI tools.
- Interviews with industry experts and Key Opinion Leaders

3.6 Technology marketing and advancing a lead closer to deal-making

Before a TTO starts technology marketing activities, it needs to understand what it is marketing, what are the “assets” available for a transaction, and what a potential partner (licensee or buyer) may seek to acquire rights from the TTO. Please see Appendix 1 for a more detailed discussion on this topic. It is recommended that a TTO build and maintain a database of all “transactable assets” or “technology” available to it.

A technology assessment (as described in Section 3.5) will help the TTO not only understand the value proposition of the technology but also help prioritize the technologies for marketing and identify a preliminary list of prospective licensees.

The next step then is to develop marketing collaterals such as a Technology Brief or a brief Presentation that can be sent to prospects.

A Technology Brief is a non-confidential, well-written and brief (usually one-page) document that describes a technology, the value proposition, the market opportunity and current status of technology development and IP to initiate a discussion with prospective clients/ licensees. The Technology Brief is written in simple jargon-free language to interest a wider audience to seek more information. Many TTOs around the world list the Technology Briefs on their website and also on searchable databases. A crucial aspect of the Technology Brief is the segment on value proposition that has to spell out clear reasons why a potential licensee may be interested in the technology. More information on how value proposition analysis is carried out is provided in Appendix 3. An interesting and unique aspect of carrying out value proposition analysis for technology marketing is often the need to do the analysis in two parts:

- Part 1 (for the transaction between licensor and licensee): Value proposition of the technology on offer and value that may be created for the licensee.
- Part 2 (for the transaction between licensee and their eventual customer of the end product that they produce): Value proposition of the end product (that will be made using the technology by the licensee) and the value that may be created for the end customer.

The following is an example to illustrate why the two-part analysis as mentioned above is important. Consider a case where a licensee is interested in licensing a technology from an academic organization only to have rights to a non-infringing process to make a well-known and standardized product. The product is already known. The end customer already has access to the end product and is aware of the value being created for the customer by the end product. A competitor has a patent protected process to make the product. The licensee wants to make the same product but does not have a non-infringing process to do the same. The licensee licenses the technology. Here the process technology is not going to create any new additional value for the end customer. However, it allows the licensee to produce a well-known end product they could not so far. In this case, the technology marketing team will need to point out the non-infringing nature of the technology to the licensee much more than the virtues of the end product. In contrast, consider a technology to make a new end product (offering new and differentiated value to end-users). In this case, the technology marketing team will need to focus on how the end product can create new value for end customers.

Following this, the process of technology marketing is very similar in nature to the marketing and sales processes followed in other industries. This is described in Appendix 4.

Identifying prospective partners and outreach to make these partners aware of the technology could involve:

- Distributing Technology Briefs through websites, social media, mailing lists, technology databases, etc.
- Attending trade shows, conferences, and networking events
- Leveraging databases (e.g., LinkedIn, Crunchbase, patent databases) to identify leads
- Leveraging the professional networks of the inventors and senior leaders of your organization
- Distributing over a carefully curated database of technology scouts in industries of interest

Targeted marketing with carefully identified prospects (suggested by industry experts in your network) and marketing by leveraging the professional networks of the inventors often yield better results.

During the outreach and lead generation phase of technology marketing, the resourcefulness and relationship-building skills of the technology marketing team are very important.

Prospects who show interest are classified as leads. Qualifying and advancing the leads often involves multiple phone calls, discussions, mutual visits and exchange of information. Both parties would need to gauge each other for seriousness, fit, capacity, intent, timelines, suitability for collaboration, credibility, track record etc. Very often the potential licensee is also looking to build internal conviction on the opportunity that the technology represents; thus, it is the task of the technology marketing team to provide all information that can help their counterpart build conviction for themselves and within their team.

In the middle of the funnel, which involves qualifying and advancing a lead, patience and persistence are desirable virtues for the technology marketing team.

The final stage of business development is to convert the lead into a deal. The potential licensee may show interest in taking the discussion further by requesting that the two parties sign a Non-Disclosure Agreement (NDA) and enter into more detailed and confidential discussions. The client may wish to carry out a technology and IP due diligence at their end. The client may request samples for testing and evaluations. Finally, the client may wish to discuss deal structures and modes of engagement. They may also request a term sheet.

Tech Marketing Template

Technology available for licensing

company logo

Heading

A crisp title that captures the uniqueness of the technology as well as the target users for the technology (if known)

Technology Summary

One sentence about the technology capturing its key business aspects such as scalability, environment friendliness along with the uniqueness of the technology.

Background

Brief description about the limitations of the current technology and/or why there is a need for a better solution to solve the problem at hand. You may also mention any relevant details about current research in the specific field and how the technology developed is relevant to it.

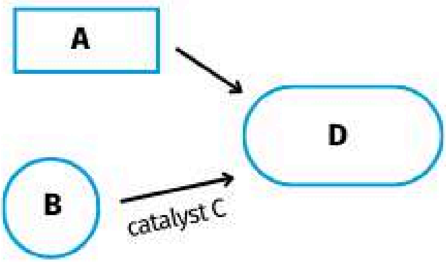
Value Proposition

- Highlight pointwise (preferably) the value created by the technology to target customer/user
- Include pointers on the benefits offered by the said technology over the current limitations to achieve a particular set of desired customer outcomes. Include
  - Pains
  - Gains
  - Gain creators
  - Pain relievers

Technology Description

One paragraph **(preferably summarized in 100 words)** on the science behind the technology (may include chemical or biological reactions, electrical component design, schematic diagram to show the working of a technology, etc.)

Schematic or block diagram/ chemical reaction
Example:



Tabular representation showcasing important current experimental data/efficiency of technology.

Parameter	Test Method	Measured value	Units

Market Opportunity

Statistics to support the estimated number of users (in India/globally) for the technology (TAM/SAM/SOM), overall market size (in $/ CAGR)

Technology status

Patent status (filed/accepted/granted/published), any pilot scale demonstration if done, any publications, current efficiency of the technology with respect to studied parameters

References Add any contact details to help an interested party to get in touch for further discussion.

The tool kit for a technology marketer and business developer includes:

- Database and collections:
    - Technology Briefs
    - Technology presentations
    - Database of the organization's patents
    - Database of industry contacts; Rolodex equivalents
- Templates:
- Non-Disclosure Agreement (NDA)/ Confidentiality Agreement (CDA)
- Materials Transfer Agreement (MTA)
- Subscriptions (if required):
- Market research databases
    - Patent databases
- Software systems (for mature TTOs):
    - CRM

> "A 'hot' academic technology is one that has two potential licensees"
>
> Dr. Ashley Stevens says to indicate how difficult it is in practice to find takers for academic inventions.

3.7. Technology transfer deal structures/ agreements, negotiations and closing a deal

The suggested sequence of deal-making (after qualification of leads) is as follows:

- Close all technical discussions first. Build conviction on the technology and IP, its value proposition and business opportunity. Allow completion of technology due diligence.
- Get clarity on the technical scope of rights that the potential licensee requires with regard to know-how, IP, data, samples and other support. Accurately gauging the technical scope and limiting it to what is being asked is an important skill for dealmakers. A very small scope may not serve the purpose of the potential licensee, or cripple their ability to grow the company or arrange resources for further development. Too large a scope may result in the TTO quoting too high a price.
- Evaluate multiple deal structures (options, licenses, assignment, joint development, etc.) that will best serve the interests of the academic/ research organization as well as meet the requirements of the potential licensee. Effective deal structuring is the hallmark of an experienced Tech Transfer Professional. An important task is to find a reasonable balance in risk and reward sharing for all parties concerned.
- Deal structuring also requires considerable strategic and tactical planning so as to help stage the next stage of commercial discussions, and also sometimes anticipating potential problems in agreement enforcement after the deal is inked.
- Propose a term sheet (also called the Heads of Agreement in the UK) with a deal structure clearly outlining the commercial terms which shall be negotiated next after concluding discussions on the deal structure. The commercials may not be spelt out at this stage but reserved for the next stage of negotiations.
- The final stage of negotiations deals primarily with the commercial terms. However, if commercial terms are not mutually agreeable, then one has to go back to the deal structure terms and technical scope to suitable modify to arrive at fresh commercial terms. This stage involves iterations and considerable creativity in deal structuring! Reasonable flexibility of both parties is quite important for deal closure. Often genuine trust and respect built between the two parties is an important ingredient in moving closer to a deal. This stage involves iterations and considerable creativity in deal structuring!

Reasonable flexibility of both parties is quite important for deal closure. Often genuine trust and respect built between the two parties is an important ingredient in moving closer to a deal.

Section of term sheet	Terms
Preliminaries and scope	• Parties • Knowhow • Patents • Data/ samples • Technical support in commercialization
Definitions (used for limiting scope of license)	• Field of use • Product • Milestones
License or equivalent rights	• Combinations of license/ options/ sale or assignment/ sub-license rights • Exclusive/ non-exclusive/ limited exclusive • Duration of the license or equivalent right with scope for extension • Limitations: Geography • Limitations: Field of use/Modes of commercialization/ others
Financial arrangements	• Upfront or one-time fee/ Option fee • Milestone fee • Annual minimal license fee • Running royalties • Reimbursements
Other important clauses	• Confidentiality • Responsibility of compliances • Assurance and warranties (no assurances or warranties) • Indemnities • Rights on foreground IP
Boiler plate clauses	• Other standard clauses found in license agreements

Table 15: Key elements of a licensing term sheet

A few words of advice for Technology Transfer Professionals:

- Deal structures should be designed to head to a deal closure and have enough scope for flexibility to allow a closure and not a stand-off.
- The best deal structure for early stage technology licensing is probably one that strengthens and empowers the licensee to raise necessary resources to advance the technology, attract support, reduce risks and reward investors in the technology handsomely. This is because finding suitable committed licensees for early-stage, high risk technologies is quite difficult globally and the risks and uncertainties are so high that the odds of value creation are highly dependent on the commitment and persistence of the licensee.
- Technology Transfer Professionals should refrain from tilting deal structures entirely in favor of the academic and research organizations. Such deal structures are more likely to not head to deal closure with serious licensees and may not lead to long-term success of the technology.

Such deal structures are more likely to not head to deal closure with serious licensees and may not lead to long-term success of the technology.

Pointers for deal structuring:

- Be creative in designing deal structures that are win-win deals. Be flexible and avoid using frozen template agreements.
- Design terms to have enough parameters to tweak and take negotiations progressively to a closure rather than a stand-off.
- The best deal structure for early stage technology licensing is probably one that strengthens and empowers the licensee to raise necessary resources to advance the technology, attract support, reduce risks and reward investors in the technology handsomely.
- Deal structures that tilt unfairly in the direction of the technology provider often do not attract licensees with serious intention of creating success and sharing rewards.

“Who is the ‘client’ of a Technology Transfer Professional? After many years of practice, I realized that the real client is the “technology” itself. The goal is to ensure the success of the technology.

Dr. Richard Cahoon says that a TTP needs to work towards the success of the technology when faced with many stakeholders.

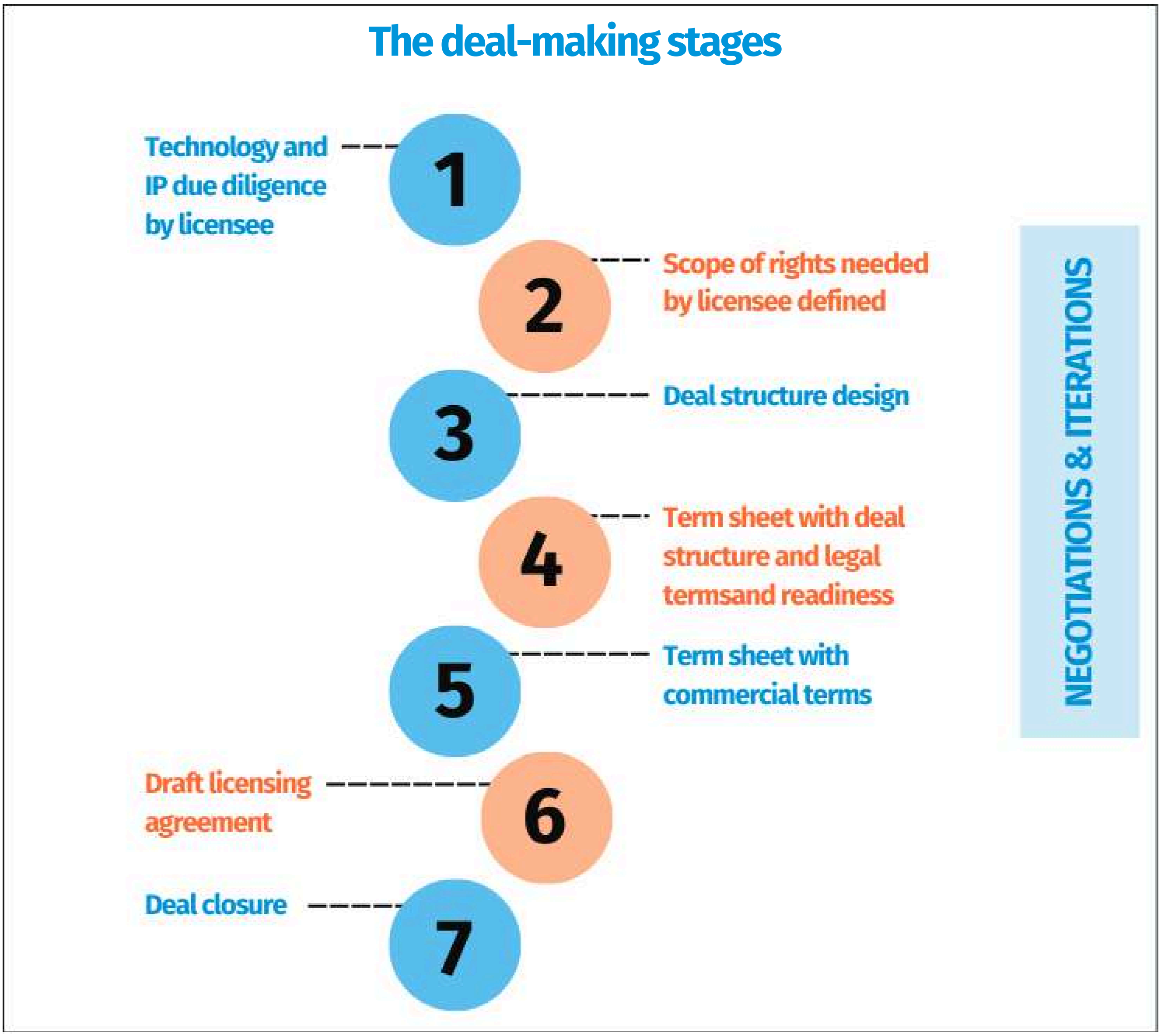


Figure 7: The Deal-making Stages

The tool kit for a deal maker includes:

- Templates:
    - Draft non-binding term sheets
    - Draft option agreement
    - Draft licensing agreement
    - Draft assignment agreement
    - Draft joint development agreement
- Guidelines:
    - Guidelines of the parent organization's legal counsel on non-negotiable clauses
    - Guidelines of the parent organization's legal counsel on preferred clauses (for example, for dispute resolutions, applicable law, place of lawsuits)

A detailed discussion of deal structures and agreement templates is outside the scope of this Handbook. However, detailed information on this in the form of expert lectures, exercises and templates are available online via the Technology Transfer Online Manual at https://manual.techtransfer.online.

3.8. Technology valuation

The first and most important point that every Technology Transfer Professional must know is that "value" of any transacted item is a subjective quantity that is highly dependent on what value the buyer sees in the technology and the seller may not have a full visibility of all the reasons why the buyer is interested in the transacted item. In technology transfer, this becomes even more complicated since most early stage technology transfer do not have multiple interested licensors/buyers to help discover price via a competitive bidding process. Thus, in practice, the price is negotiated and mutually agreed as a reasonable price to move ahead with the agreement.

This uncertainty in the price of transacting a technology asset is source of much discomfort amongst the leadership of academic and research organizations (especially in publicly funded organizations) who are expected to justify the terms agreed upon. While organizations have come up with mechanisms to justify the price agreed, the following are practical approaches to deal with the concerns:

- Have a deferred fee or running royalty term in order to ensure risk and reward sharing linked to performance
- Have terms such as Annual Minimum License Fees to terminate licenses in case of non-performance
- Have a committee or a group of experienced professionals ratifying the agreed terms

Despite the subjectivity involved in pricing of early stage technology, it is advisable for Technology Transfer Professionals to carry out an internal valuation exercise to prepare for a negotiation especially to understand the levers of value creation much more than actual numbers that may be cited. A typical valuation exercise comprises the following steps:

- Identify various sources of value creation including:
    - Value created by manufacturing and selling a product using the technology
    - Value created by keeping the competition out of the market or preserving market share
    - Value created by improved margins (by reducing costs or increased prices)
    - Unique value created by closing a key gap in the development plan of the company
    - Value created by reducing key risks for the licensee including accident risks, supply chain risks etc
    - Value created by being able to bundle this new technology with existing technology for the customers of the licensee
- Creating a model on a spread sheet that best simulates the sources of value creation given certain assumptions (that can be separately verified using market research). Examples of mathematical models include:
    - Cash flow discounting
    - Price calculations using comparable (if data on a close comparable is available)

It is important to note that the cost of producing a technology is irrelevant to the valuation of a technology especially for early stage technologies created by academic and research organizations after many failed experiments and meandering exploratory efforts in an inefficient organizational environment.

It is important to note that the cost of producing a technology is irrelevant to the valuation of a technology especially for early stage technologies created by academic and research organizations after many failed experiments and meandering exploratory efforts in an inefficient organizational environment.

Certain cost such as patent protection costs can be accurately documented and sought as patent reimbursement costs in case of exclusive licenses and assignments.

A detailed discussion of technology and IP valuation is outside the scope of this Handbook. However, detailed information on this in the form of expert lectures, exercises and templates are available online via the Technology Transfer Online Manual at https://manual.techtransfer.online.

3.9. Post-deal contract life cycle management

Monitoring agreements after the agreement is executed is an important roles of a TTO and is crucial for not only ensuring that licensing related payments are received but also to ensure continued support of the academic and research organization for the team that is commercializing the technology. A happy and successful licensee may not only come back to the academic and research organization for further licensing and/ or sponsored research projects and/or hiring students of the academic/ research organization. In the final reckoning, the success of the licensing academic/ research organization (typically non-profit organization) may be recorded more in terms of the success and impact created by the licensee and the licensee organization's part attribution to the success to the role played by the licensee rather than the licensing fee that would be collected from the licensee.

Post-deal contract life cycle management or agreement monitoring is best done if the process can be systematized. TTOs may wish to assign every agreement to a manager who shall be responsible for monitoring the agreement and maintaining relationships with the licensee. It is a good practice to provide a reporting template for licensees as an appendix to the license agreement. It is also considered a good practice to allow for audits of the licensees production and sale records with reasonable periodicity.

The tool kit of an agreement monitoring manager includes:

- Databases:
  - Database of agreements with milestones (for deliverables by licensor and licensee, reporting, payments, review meetings) and dates
  - Directory of point-of-contacts in licensee companies
  - Compilation of information updates regarding every technology licensed such as patents approved
- Templates:
  - Annual reporting format for licensees
  - Invoicing formats
  - Distribution formats (if the organizational policy allows distribution of revenues)

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Progress by innovation

4

Section 4 :

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Specialized activities undertaken by the TTO

This section discusses a few selected specialized activities of a TTO such as new venture creation and other specialized technology commercialization models.

4.1. Tech venturing and spinouts

Tech venturing or new venture creation or start-up creation refers to creation of new ventures to license the research results and advance them closer to market introduction. In such cases, know-how and/ or IP and/or other capabilities from the academic/ research organization is central to the business story of the new venture.

Usually, spinouts are a special class of new ventures where the parent organization (in this case academic/ research organization) has stake in the new venture (directly or indirectly via partners) and thus participates in the nurturing its success. In a manner of speaking, an academic/ research organization is said to have "spun out" a part of its activities into a more focused, entrepreneurial entity – the spinout.

In the last three decades, new venture creation has become an increasingly popular mechanism of commercialization of technology from academic/ research organizations. Some key factors driving this trend include:

- Availability of innovation/technology translation/proof-of-concept funding mechanisms
- Easier access to seed, angel and early stage venture capital funds
- Emergence of technology licensing models with equity-based or deferred payment mechanisms
- Reduced licensing of early stage research technologies by large firms and their increasing preference to join value creation late in the journey of technology translation
- Increasing awareness and confidence amongst researchers to explore entrepreneurship as more and more role models and success stories emerge
- Increasing frustration of researchers with not finding suitable partners who will be interested in investing in and advancing their technologies

While the new venture creation route places considerable additional responsibilities on the inventors (if they are part of the new venture), it also offers some new advantages to the inventors, such as the following.

- New venture creation brings a sharper focus and attention to a specific business objective (made possible by the licensed technology) and separates this from other activities of an academic/ research organization. This helps attract partners in the form of cofounders, collaborators, funders, investors etc who are specifically interested in this technology/ business goal.
- New venture creation allows for speed, nimbleness and flexibilities
- New venture creation allows tapping of resources meant for new start-ups and also enable investments by venture capital firms (who might seek greater control and lucrative exit opportunities)
- New venture creation provides the inventors to play a larger role in shaping the future of the technology and not be reliant on high-level decisions of large companies

TTOs have also been transforming to facilitate this relatively new mechanism of technology commercialization. TTOs that support new venture creation often undertake additional activities to promote and support new venture creation activities. These could include:

- Creation and implementation of enabling policies relating to licensing to start-ups, equity-based models of licensing, faculty entrepreneurship, student entrepreneurship and conflict of interest/ commitment management.
- Awareness, training programs and competitions in entrepreneurship

- Mechanisms to offer licensing agreements involving equity and equity-linked securities
- Entrepreneurship clubs for students
- Proof of concept grants
- Incubation centers and programs to support new entities
- Seed funds for start-ups

New ventures or start-ups often have severe resource constraints. Whatever resources they raise through grants and investments are provided by funders and investors often with explicit instructions for use in advancing and de-risking the technology and not for pay-outs as licensing fees. The general expectation is that the academic/ research organization will participate in the risk associated with the technology translation and receive rewards at a suitable later date. This necessitates the use of equity or equity-linked securities as instruments to participate in the new venture. This is usually a complexity that many academic/ research organizations have not dealt with previously and hence causes delays in execution.

In many countries, tax-exempt non-profits organizations (with some exceptions – such as government-approved non-profit entities permitted to hold equity such as government-approved incubators in India) are not allowed to hold equity in private, for-profit entities. This means that many non-profit academic and research organizations have the following options to provide licensing models with equity and equity-linked mechanisms:

- Stay with traditional models of licensing but emphasis running royalties and milestone payments rather than upfront payments
- Consider valuation linked payments linked to valuation/ fund raise milestones
- Engage a trusted third party or partner organization to hold equity or equity-linked instruments in new ventures but provide deferred payments to the academic/ research organization. Example entities could be incubators associated with the academic/research organization or technology marketing entities. In such cases, academic/research organizations should get professional advice from legal and taxation experts before proceeding ahead.

It has been the experience of Venture Center that the most important determinant of success of new ventures emerging from academic/research organizations has been the quality, commitment and persistence of full-time entrepreneurs driving the new venture. In this context, TTOs need to create an environment and ecosystem that attracts and welcomes potential full-time entrepreneurs, provide them attractive licensing terms and a supportive incubation experience.

4.2. Other models of technology commercialization

One of the very interesting aspects of a career in technology commercialization is that every case is different and requires specialized treatment. A “cut and paste” approach to building win-win partnerships and deal structuring can lead to disastrous consequences. This of course means that Technology Transfer Professionals need to be perceptive and creative in performing their role. While this is often a lot of intelligent hard work, it is also an opportunity to bring creativity to bear on ones job while nurturing opportunities for impact. Some of following specialized models of commercialization illustrate the diversity in partnership models in technology commercialization.

Standard Essential Patent/Fair, Reasonable and Non-Discriminatory Licensing:

- Some technologies become industry standards and their wide spread adoptions allows the industry (and the other industries dependent on it) as a whole to grow rapidly leveraging the benefits of standardization. However, these technologies will be accepted as industry standards only if it is available all potential users freely or on fair, reasonable and non-discriminatory licensing terms. Examples of such technologies include Wi-Fi (IEEE 802.11), USB (Universal Serial Bus), Advanced Video Coding (MPEG-4 Part 10/H.264), 4G LTE (Long-Term Evolution) and 5G telecommunications.

- A standard essential patent (SEP) is a patent that protects an invention essential to the implementation of a particular technology standard.If a researchers come up with an SEP, then that patent may need to be licensed to all desiring licensees using a Fair, Reasonable and Non-Discriminatory Licensing (FRAND) whose terms seeks to strike a balance between SEP owners' interests in recouping research and development investments, on the one hand, and access to standardized technologies by implementers, on the other. Under the FRAND mechanism, licensors need to provide non-exclusive licenses to all licensees (without refusing to anybody or offering differential terms). The terms need to be reasonable and be extortive (now that the technology has been adopted as a standard).

Patent pools:

Sometimes, different owners of related or complementary patents covering a given technology may pool their patents together and license them together in order to make possible a complete (rather than piece meal) technology offering, simplify the technology transfer transaction and optimize the cost of deal-making.

UN Medicines Patent Pool (MPP):

The MPP aims to improve access to medicines and health technologies, particularly in low income (LIC) or low medium income countries (LMIC) through non-exclusive voluntary licensing by the innovator companies to the other manufacturers who agree to a) not enter the middle income and high income countries, b) make available the drugs at an affordable price in LIC/ LMIC countries and c) pay a pre-agreed royalty (if any).
More information at: https://medicinespatentpool.org

Mission-mode non-profit innovation entities focussed on technology commercialization:

- Mission mode non-profit innovation entities focus on specific large and meaningful goals with considerable potential societal impact. They aggregate resources from funders and donors to mobilizetechnology advancement and de-risking activities and catalysing collaborations (including industry-academia partnerships). These entities enter into agreements with both academia, industry and funders that include terms for intellectual property rights and technology transfer.
- For example, the Medicines for Malaria Ventures (MMV) is a non-profit entity focused on antimalarial drugs and the mission of eradicating malaria. MMV has forged partnerships with 700+ partners including academic institutions, research organizations, industry, Government, donors and non-governmental organizations spanning 72 countries. The MMV has developed collaboration models that enable sourcing (in-licensing usually) of drug assets, its further development through pre-clinical and clinical validation stages via partners and finally licensing to partners for manufacturing and sales. The collaboration models have to be designed to keep the new drug accessible and affordable while providing reasonable and attractive financial return to the manufacturing sales partner. More information at: https://www.mmv.org/

Creative Commons licensing:

Creative Commons (CC) is a non-profit organization that provides free legal tools for creators to share their work with "some rights reserved," instead of the standard "all rights reserved" copyright. This empowers artists, educators, and scientists to specify how others can use their work (e.g., allowing non-commercial use or adaptations) through a set of six standardized, easy-to-understand licenses. The primary goal is to grow the "commons"—the vast amount of creative work available for legal reuse—fostering a more collaborative and open digital environment for global knowledge sharing and creativity. More information at: https://creativecommons.org/

Open source licensing:

- Open source licensing is a legal framework that allows software to be freely used, modified, and shared, using copyright law to grant specific permissions while protecting original creators. Its purpose is to foster collaboration, innovation, and transparency by ensuring the source code remains openly available.
- Licenses fall into two main categories:
  - Permissive licenses (e.g., MIT, Apache 2.0) impose minimal restrictions, allowing use in proprietary projects.
  - Copyleft licenses (e.g., GPL) require that any modifications or derivative works also be distributed under the same open source license, ensuring the code remains free for everyone.
- Choosing the correct license is essential for legal compliance and defining the rules of community engagement.

These licenses form the legal backbone of the open source ecosystem, balancing intellectual property rights with community-driven development. More information at: https://opensource.org/osd

4.3. Selected case studies & examples of commercializing research

The Langer Lab: A case study in commercializing science through an interdisciplinary ecosystem

Robert S. Langer's laboratory at the Massachusetts Institute of Technology stands as one of the most compelling examples of how academic research can systematically translate science into societal impact. Prof Langer is probably the single most influential role model for many scientists and engineers interested in translational research and technology commercialization.

Academic & research excellence

Prof Langer is one of 9 Institute Professors at MIT; being an Institute Professor is the highest honour that can be awarded to a faculty member. Prof Langer has written more than 1,600 articles. He is the most cited engineer in history (h-index 332 with more than 460,000 citations according to Google Scholar). Prof Langer has received over 220 major awards. Prof Langer has been elected to the National Academy of Medicine, the National Academy of Engineering, the National Academy of Sciences, and the National Academy of Inventors in the USA. He is one of 3 living individuals to have received both the United States National Medal of Science (2006) and the United States National Medal of Technology and Innovation (2011).

Track record of inventing, licensing and new venture creation

Amongst other awards, he has also received the Lemelson-MIT prize, the world's largest prize for invention for being "one of history's most prolific inventors in medicine." Prof Langer has over 1,500 issued and pending patents worldwide. Prof Langer's patents have been licensed or sublicensed to over 400 pharmaceutical, chemical, biotechnology and medical device companies. Prof Langer is said to have founded roughly 40 start-up companies – the most famous of them being Moderna (one of the first companies in the world to launch an mRNA vaccine during COVID 19

The mindset of innovators

Prof Langer has spoken about his early career and the choices he made that have shaped his extra-ordinary career. Here are a few quotes:

- Willingness to follow "The Road Not Taken": "My career has not been straightforward. In a way, I followed Robert Frost's poem "The Road Not Taken." Although I am a chemical engineer and I'm proud of that, I took a path from chemical engineering to nanotechnology to biology and medicine. This was very unusual many decades ago. In so doing, I met with rejection and ridicule early in my career. However, by going down that path I was able to make discoveries that I hope have saved and improved lives..."

- The deep desire to "have great impact or change the world". Another quote –"One of my goals in doing laboratory work has been to move beyond just conducting experiments and publishing the results to applying that work to helping people. "
- A strategy to resource impact creation: A quote articulate Prof Langer's thoughts –"I also wanted the inventions and materials we developed to help patients. This was difficult because it takes a great deal of money to develop medical products. So, I began writing patents. We licensed or sublicensed those patents to over 400 companies and I even helped start a number of companies. I should add that when I wrote these patents and helped start these companies, many scientists looked down upon it. But today, these companies have made numerous products that treat patients with cancer, heart diseases, COVID, and many other sicknesses. These companies have also created many thousands of jobs."
- Taking things in one's own hands: "Both companies gave us grants and promised to do experiments to develop our invention. However, these companies were large, and they'd do a few experiments and when they didn't work optimally, they gave up. So, a few years later Alex Klibanov, said "Bob, why don't we start a company ourselves?" I was able to get these patents back and we started a company called Enzytech which later merged to become Alkermes."

A unique model of technology transfer

- Prof Langer has built a model of technology transfer rooted in interdisciplinary collaboration, intellectual generosity, and problem-driven innovation. At the core of Prof Langer's philosophy lies the belief that academic research should create things that change the world. His approach to technology transfer blends scientific rigor with entrepreneurial thinking.
- Researchers were encouraged to identify ideas with broad societal potential and pursue early patent protection, often before publication, through MIT's Technology Licensing Office. Prof Langer's close relationship with this office ensured that discoveries move efficiently from the bench to the marketplace, frequently through start-ups that preserve the lab's spirit of collaboration and innovation.
- Prof Langer's mentorship style amplifies his lab's technology transfer success. More than 400 of his former students and postdocs have become professors worldwide, spreading his translational ethos across academia. Venture capitalists describe him as a "scientific venture capitalist" whose currency is ideas and talent rather than equity. His generosity sharing credit, patents, and professional networks creates a self-reinforcing innovation ecosystem. Colleagues note his exceptional responsiveness and his ability to manage numerous projects while maintaining deep scientific engagement.
- The "Langer Model" integrates four essential elements of effective technology transfer:
  - Identifying high-impact societal needs (IMPORTANT NEED)
  - Producing foundational scientific discoveries (SEMINAL PAPER)
  - Securing early patent protection (BLOCKING PATENT), and
  - Conducting proof-of-concept studies to attract partners and investors (PROOF OF CONCEPT/ PROOF OF VALUE DATA).
- His lab demonstrates how an academic setting can operate simultaneously as a research incubator, a training academy, and a commercialization engine without compromising academic integrity. Ultimately, the Langer Lab exemplifies how visionary leadership, structured mentorship, and a culture of interdisciplinary collaboration can transform academic science into global impact. Its legacy serves as a blueprint for universities and technology transfer offices seeking to translate research excellence into innovations that improve lives proving that when science meets entrepreneurship, discovery becomes destiny.

More on Prof Langer's background and life can be found at:

- https://langerlab.mit.edu/langer-bio/
- https://www.kavliprize.org/robert-langer-autobiography

This case study is adapted from a case study originally developed by Dr Ashley Stevens.

The THPE Story: A New Route and a New Supplier

A global technology from India

The story of the commercialization of THPE (1,1′,1″-tris(4′-hydroxyphenyl) ethane) is an exemplary case of how casual scientific collaboration, strategic partnerships, and innovation can lead to a breakthrough in technology commercialization. THPE is a key cross-linking agent used in the production of branched polycarbonates—high molecular weight thermoplastics essential for manufacturing durable, large-sized blow-molded plastic containers such as 20-liter water bottles. These polymers possess superior melt strength and structural integrity, making them ideal for large-scale industrial applications.

Identifying the problem requiring a technology solution

Before the 1990s, the global THPE market was monopolized by Hoechst Celanese Corporation (USA), which held the patent for its production and operated the only plant in Salisbury, North Carolina. This monopoly forced companies like GE Plastics (later SABIC Innovative Plastics) to depend entirely on Hoechst Celanese for their THPE supply, often at high costs. Seeking an alternative source and production method, GE's Dr. Ashok Mendiratta, during a visit to India in 1991, casually discussed this challenge with his friend Dr. S. Sivaram from the National Chemical Laboratory (NCL), Pune. This informal conversation sparked what would become an 11-year journey toward an innovative, patented, and industrially viable process for THPE manufacturing.

Formalizing industry-academia collaborations

In 1992, GE signed a research contract with NCL to explore an alternative route for THPE synthesis that would bypass Hoechst Celanese's patent restrictions. By 1993–94, NCL's Polymer Chemistry Division, led by Dr.Sivaram, demonstrated promising lab-scale results. GE's internal interest grew, and Dr. Sivaram was invited to present his findings at GE's Mt. Vernon site in 1994. Around the same time, another GE researcher, Dr. Raj Varadarajan from the Schenectady R&D site, independently contacted NCL's Director, Dr. R.A. Mashelkar, to discuss collaboration opportunities. Upon learning about the ongoing THPE project, he recognized its potential strategic value and initiated broader institutional collaboration between GE and NCL, formalized in 1996.

Advancing the invention with industry partners

The NCL team's success in developing a novel synthesis route led to a pilot-scale demonstration of the process. However, the next challenge was scaling up production and sourcing the key raw material, 4-hydroxyacetophenone (4-HAP). Ironically, most suppliers of 4-HAP, including Hoechst Celanese, were tied to the very company NCL was trying to circumvent. The breakthrough came when Dr. Sivaram identified Excel Industries Ltd., a Mumbai-based agrochemical manufacturer, as a potential industrial partner. Excel already produced 4-HAP for agrochemical applications and had the technical and infrastructural capacity for large-scale chemical manufacturing.

The importance of patents and non-infringing technologies

Dr. Sivaram proposed that Excel become the first Indian toll manufacturer of THPE. With GE's approval and compliance verification for safety and environmental standards, Excel successfully scaled up the process. In 2002, the new THPE manufacturing technology was commercialized in India, marking the end of Hoechst Celanese's monopoly. The process (a non-infringing route) was patented in the U.S. (1999) and India (2003), ensuring GE could legally import Indian-produced THPE without infringement.

An example of win-win partnerships between industries and academia

This collaboration between GE, NCL, and Excel Industries transformed an informal idea into a commercial success. The NCL team received the CSIR Technology Award in 2003, recognizing their innovative contribution. The THPE story thus stands as a model of how academic–industry partnerships, driven by scientific ingenuity and mutual trust, can yield globally competitive technologies and catalyze industrial innovation in developing economies like India.

A longer version of this case study can be found at: http://casehistory.nclinnovations.org/?p=11

The NARI Suwarna Sheep – A Breakthrough in Genetic Innovation for Rural Development

Collaborations between academia and NGOs for social impact

The development and commercialization of the NARI Suwarna sheep is an exemplary case of technology transfer and collaborative innovation between a public research institution and a non-governmental organization. This project, jointly undertaken by the Nimbkar Agricultural Research Institute (NARI), Phaltan, and the National Chemical Laboratory (NCL), Pune, successfully combined field-based animal breeding with cutting-edge molecular genetics to enhance rural livelihoods. The outcome was a new breed of sheep that doubled the income of local shepherds through increased lamb production, demonstrating the transformative impact of science and technology in rural development.

Passionate social workers as sources of problem definitions for inventions

In India, sheep are primarily raised for meat rather than wool, and the income of shepherds depends directly on the number of lambs born. Most native breeds, such as the Deccani sheep of Maharashtra, have low prolificacy—typically producing only one lamb per pregnancy (average litter size 1.04). Maintaining large flocks to ensure adequate income strained local resources, as grazing land was scarce. Recognizing this challenge, animal breeder BVNimbkar of NARI sought to introduce prolificacy (the ability to produce multiple lambs) into the Deccani breed.

His search led him to the Garole sheep of West Bengal's Sunderban region—the only prolific sheep breed in India, known for its high fertility (average litter size 1.8). Between 1993 and 1999, Nimbkar transported Garole sheep to Maharashtra to initiate a cross-breeding program with the Deccani breed. However, while Garole sheep were highly fertile, their small body size made them less suitable for meat production. The breeding objective was therefore to combine the prolificacy of the Garole with the size and hardiness of the Deccani.

Finding technology development partners and building collaborations

In 1996, Nimbkar sought the expertise of Dr. Vidya Gupta and her team from NCL's Biochemical Sciences Division to perform molecular DNA analyses of the parent and hybrid sheep. Funded by the Australian Centre for International Agricultural Research (ACIAR), a joint NCL–NARI program began in 1998 to identify and transfer the fecundity gene (FecB) responsible for prolificacy. A scientific breakthrough in 2001 by AgResearch New Zealand confirmed that a specific mutation in the FecB gene increased litter size. NCL's team successfully detected this mutation in the Garole sheep and later in their Deccani crossbreeds through molecular testing. After several generations of selective breeding, a new sheep variety was established in 2005 that retained the robustness and physical traits of the Deccani while inheriting the prolificacy of the Garole. This new breed, named NARI Suwarna, carried the homozygous FecB gene mutation and consistently produced twin lambs. Field trials from 2005 to 2009 demonstrated that NARI Suwarna sheep integrated well into local herds and doubled the shepherds' income through enhanced reproductive rates.

Technology transfer and the implementation in rural settings by NGO partners

To ensure sustainability, NCL transferred the molecular diagnostic know-how to NARI, enabling them to independently perform DNA tests for further breeding programs. By 2009, a nucleus flock of over 500 NARI Suwarna ewes had been established, and local shepherds continued to benefit from the technology.

This project stands as a landmark example of successful technology transfer between a publicly funded laboratory (CSIR–NCL) and a rural development NGO (NARI). It integrated modern biotechnology with traditional animal breeding to address a pressing socioeconomic issue. In recognition of this achievement, NCL and NARI jointly received the CSIR Award for Science & Technology Innovations for Rural Development (CAIRD-2007), presented by Prime Minister Dr. Manmohan Singh. The NARI Suwarna initiative thus exemplifies how collaborative science can create sustainable technological solutions for rural prosperity.

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Progress by innovation

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Section 5 :

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Commercializing clean technology innovations

This section focuses on the unique challenges in the commercialization and technology transfer of clean tech innovations.

5.1. Introduction to clean technology innovations

Clean technology innovations (often called cleantech) refer to new or improved products, processes, or services that result in relative positive environmental impact compared to status quo. This could be via a variety of mechanisms:

- Reduce pollution of air, water, soil etc
- Reduce wastes, promote a circular economy, promote compost-ability of wastes
- Reduce/optimize resources and energy utilization for the same results
- Reduce generation and emission of greenhouse gases like CO_2 and CH_4
- Actively convert wastes, emissions, effluents etc to benign or useful products
- Transition to greener alternatives in fuels, energy sources, industrial processes, consumer products etc

The following are categories of cleantech innovations that are seeing considerable research and technology development efforts today:

- Clean energy generation: Solar power, wind energy, hydro power and tidal energy, geothermal energy, nuclear fusion
- Fuels: Hydrogen, biofuels
- Energy storage: Battery technology, grid storage
- Energy efficiency: Smart grids, efficient appliances, better building materials
- Sustainable mobility: Battery powered electric vehicles, hydrogen powered vehicles
- Waste reduction and circular economy: Recycling, compostable materials, sustainable packaging, waste to value, innovative business models using extended producer responsibility credits
- Reduction of greenhouse gas emissions: Industrial decarbonization, process innovations for CO_2 reduction including alternative process routes or raw materials, reduction of methane emissions, innovative business models using carbon credits, alternatives to animal-sourced proteins and nutrients
- Carbon capture, utilization and removal: Direct air capture, carbon utilization, carbon storage/sequestration
- Water purification and conservation: Desalination, water recycling, waste and water loss reduction
- Pollution reduction and control: Air pollution monitoring, reducing emissions of pollutants, innovations to reduce water pollution and treatment, innovations in reduction of contaminants
- Sustainable production: Biomanufacturing, climate resilient agriculture, environmentally safe farm inputs

A longer introduction to Cleantech is available at: https://www.cleantech.org/what-is-cleantech/

The Facility for Low Carbon Technology Deployment (FLCTD) Project of the UNIDO supported by UNIDO, BEE and GEF is an example of a program supporting clean tech innovations. It was launched in 2016 with an objective to identify innovative energy efficiency and low carbon technology solutions that address the existing technology gaps in Indian industrial and commercial sectors. The FLCTD program prioritized the following areas of focus:

- Waste Heat Recovery
- Pumps & Pumping system
- Motors
- Space conditioning
- Industrial IoT
- Industrial Resource Efficiency
- Electrical Energy Storage

5.2. Qualifying technologies as "cleantech"

A technology qualifies as a clean tech innovation when it meets specific environmental and sustainability criteria, typically aimed at reducing harm to the planet while supporting economic growth. It is important to highlight and reiterate the two parts of the statement above:

- Meets specific environmental and sustainability criteria, typically aimed at reducing harm to the planet
- Supports economic growth (has potential for large scale adoption, can be economically viable, promises positive return on investment over a reasonable time frame)

The environmental and sustainability criteria are usually specific to industries and are usually best defined in consultation with industry experts. Criteria could include individual or composite metrics. In all cases, a comparison with the business-as-usual scenario or status quo is desirable to show an improvement in overall environmental impact.

A few examples of methods used to arrive at metrics that can be compared include:

- Life cycle analysis (LCA)
    - Cradle to Grave (starting from raw material extraction to end of product life)
    - Cradle to Gate (starting from raw extraction to product exiting factory premises)
- Greenhouse Gas Accounting
    - See for example: India GHG Program: https://indiaghgp.org/standard-guidance
    - See for example: Greenhouse Gas Protocol – A corporate accounting and reporting standard: https://ghgprotocol.org/corporate-standard
- Other methods:
    - Environmental Impact Assessments
    - Resource efficiency calculations (resources could include energy, water, materials)
    - Materials flow analysis
    - Bio-based content; Non-fossil fuel content; Renewable content
    - Recycled content
    - Indicators of pollutants in emissions, effluents and other streams
    - Habitat loss, deforestation

Interested readers may wish to study the ISO standard ISO 14034:2016 titled "Environmental management — Environmental technology verification (ETV)". The objective of environmental technology verification (ETV) is to provide credible, reliable and independent verification of the performance of environmental technologies. Ref: https://www.iso.org/obp/ui/#iso:std:iso:14034:ed-1:v1:en)

5.3. Communicating the value proposition of cleantech innovations

The extraction, articulation and communication of the value propositions of cleantech innovations requires considerable extra effort on behalf of Technology Transfer Professionals (Note: Read in context of Appendix 4). This is because several clean tech innovations present potential gain creators that are more "desirable" rather than "necessary", and very often do not present any pain relievers for a majority of customers who may not yet be sensitive to the need for adopting clean tech innovations.

This should be viewed from the perspective that it is far easier to sell and raise funds for pain relievers(like say, a paracetamol) rather than for a "desirable but not a pressing need" gain creator (like say, a food supplement). In this context, rather than pushing a technology for larger good, a better approach to marketing a clean technology innovation may be to:

- Focus on the potential economic gains for licensees in terms of cost reduction and increase in margins

- Focus on the opportunity to create stable, secure and independent supply chains with reduced risk of price fluctuations, regulatory risks and geopolitical uncertainties.
- Focus on the potential mitigation of risks of compliance failure especially in the context of upcoming regulatory actions
- Focus on the potential to gain market share in a market that has growing environmentally conscious customer base
- Focus on the potential to sell at a premium price due to a "green" tag

Cleantech innovation marketers may wish to point to current trends that are increasingly favoring the adoption of such technologies:

- Several case studies have now emerged where cleantech options have rapidly made inroads into the market (after initially appearing unattractive) due to rapid drop in prices, quick adoption and improved economic viability. Top examples include the solar power generation industry and battery industry.
- Increasingly, the choices of the youngsters in the marketplace has a focus and emphasis on environmental sustainability
- Public action around visible consequences of pollution and environmental damage is becoming more common as unmanaged urbanization grows. Examples include movements with regards to air pollution and waste management in several Indian cities.
- Corporates and investors are increasingly adopting ESG reporting and auditing
- Several corporates have adopted policies against deforestation and destruction of natural habitats
- Europe has announced a carbon tax on goods sold in the EU
- The trading of carbon credits is in operation in many parts of the world
- Governments are increasingly making efforts to move away from fossil fuels. An example of this is the introduction of bioethanol blending in petrol in India.
- Governments are running campaigns on resource efficiency with an eye on national security.
- Various governments are introducing mechanisms to implement Extended Producer Responsibility (EPR). The issuance of EPR certificates has opened up new revenue models for recyclers and waste management companies.
- Recycling mandates are being seen more frequently
- COVID19 highlighted the importance of having reliable supply chains for critical inputs. This has created opportunities for recycling industries and innovators of alternate materials.
- Several cleantech innovations are growing in maturity and becoming contenders in the market. An example is the rapid increase in EV adoption in the last decade.
- Concurrent developments in digitalization, sensors, IOT, data analytics, AI, cloud infrastructure etc are providing the tools for tracking, making live data widely visible, planning actions and assessing impact for environment related metrics and indicators. This has not only increased awareness but also helped with compliance and enforcement.

5.4. Challenges associated with tech transfer and commercialization of cleantech innovations

Commercializing any innovation is about progressively reducing risks/uncertainties and complexities as one builds/demonstrates the technology and experiments with various business models. These risks/ uncertainties and complexities emerge as challenges in the commercialization process.

The following is a list of a few reasons that make commercializing cleantech innovations challenging:

- Many cleantech innovations are deeptech innovations that need longer gestation periods before revenues kick in.

- Many cleantech innovations involve considerable integration of multiple pieces of know-how/ technologies. This can result in considerable complexity in process/ product development and also business execution.
- Cleantech innovators often need to strike partnerships (especially with academic/research organizations and non-profit incubators/ innovation centers) for access to facilities and expertise. Partnership development and management become key to commercialization of such technologies. Partnerships can also result in complex intellectual property management arrangements.
- Given the nature of cleantech innovations as having potential public and social benefits besides the economic benefits, lot of early research resides in publicly funded institutions. Cleantech innovators often struggle to secure technology licenses at the right stage and in a timely manner. Cleantech innovators also often struggle to get adequate post-licensing translation support especially with regards to customization of designs, prototypes, processes etc to suit real-world situations.
- Cleantech innovators can find it difficult to arrange finances for securing IP rights at the right time.
- Most cleantech innovations are commercialized as B2B businesses where the technology is often piloted/ demonstrated in industrial sites for generating evidence for proof-of-value (especially in the absence of test beds at different scales). This means that partnerships with corporates becomes essential. A key challenge for innovators is to strike partnerships that do not compromise their ability to raise commercial investments by agreeing to restrictive terms imposed by the corporate. Setting up and managing corporate partnerships becomes a key skill required of clean tech innovators.
- Technology transfer in Climate tech has challenge of elongated cycle before the deal reaches a stage where both the sides have agreed to go ahead with the deal-making. There are several reasons for this. One reason is the regulatory and compliance dependence of climate tech push.
- Companies want to be very sure of the promise of meeting full compliance requirements from the incoming technology
- Second is the ambiguity in industry standards and required certifications. Overall, climate tech is still evolving, and there is still ambiguity around several aspects, including material, system integration, end-of-life, and emission reduction potential. This ambiguity further elongates the decision-making process. Due these reasons, the perceived risk level is higher and therefore the acceptance of new technologies directly into the core ·industrial processes is much lower.
- The deployment partners take a longer route, first integrating the technology into one of their utility processes, studying it for an extended period, and considering it for the core industrial process after a more extensive demonstration and deployment phase. The second challenge is related to the ever-rising baseline expectations that accompany every round of new technology introduction, where the new technology must meet and exceed the performance level of previous technologies by a significant margin.

This is partly because of the increasing compliance burden and the time and effort it takes to integrate new technologies into a running operation - the companies would want to maximize their returns, so the bar of expectations for each new round is much higher.

- Many cleantech innovations need considerable investments in capital expenditures to be able to generate proof-of-concept or proof-of-value evidence. Often venture capital investors are hesitant to invest in capital expenditure in early stages of a company.
- The other consequence of having a lot of requirements with respect to prototype developments/ pilot plants etc is the need for a supporting ecosystem with strong capabilities in fabrication, assembly, integration with electronics, control systems etc. India does not have too many locations with such capabilities.

- At the time that cleantech innovations are first conceived and initiated, the value propositions for adopters of the technology may appear as "desirable but not a pressing need". As the technology evolves to illustrate the economic value being created and as external regulatory environment changes, the value proposition becomes more striking. However, in the early stages many cleantech innovators struggle to convince adopters and investors.
- Very often it is seen that the adoption of cleantech innovations requires a policy push or coordinated industry action or support of committed impact investors. This imposes a risk or uncertainty for cleantech innovators.
- One other source of high risk in the commercialization of cleantech innovations is the long sales cycles involved in B2B businesses which show an interest in deploying cleantech innovations.
- Several cleantech innovations require not only a one-time product sale but also Erection, Procurement and Commissioning (EPC) support, long terms operations and maintenance commitments as well as assurances and guarantees that can place considerable pressure on nascent cleantech start-ups.
- Fund raising for cleantech project implementations often requires innovators to show pre-order commitments, offtake agreements, prepurchase commitments for carbon credits etc from corporate customers. These are quite complex and place considerable demands on a cleantech innovator.
- Commercializing many cleantech innovations require considerable investments in certification and securing regulatory approvals before field implementation or sales. This again can increase the timelines and risk profile of cleantech start-ups in the eyes of investors.

The above challenges also carry over into the technology transfer process. Technology Transfer Professionals need to be creative and empathetic to the cleantech innovator's unique challenges while designing suitable deal structures. Some issues to consider are:

- Structure the deal terms so as to help strengthen the hands of the cleantech commercialization partner for fund raising. Reduce unnecessary uncertainties and constraints in deal terms. Communication of strong commercialization support from academic/research organizations can go a long way in building confidence amongst investors.
- Factor in the likelihood of longer commercialization journeys in milestones and durations in tech transfer agreements.
- Factor in the likelihood of considerable expenses being incurred by the commercialization partner towards prototyping/ scale up, certifications, regulatory approvals etc in pricing.
- Factor in considerable risk (for example, due to policy and geopolitical trends) for the cleantech commercialization partner while thinking through pricing and risk-reward sharing mechanisms. Deal structures may need to tilt rewards to the academic/research organizations in the direction of deferred returns, including milestone payments, running royalties and equity.
- Since most cleantech innovations may involve integration of several different know-how components from multiple sources, technology transfer agreements may need to factor in the possibility of royalty stacking.
- Considering the likelihood of the commercialization partner entering into partnerships, collaborations, joint development agreements, etc or the need to enter into EPC or O&M contracts, technology transfer agreements need to provide adequate rights to allow for these arrangements.

Overall, TTOs play a crucial enabling role in successful technology transfer of cleantech innovations from academic/ research organizations, but also in facilitating their successful implementation and deployment for the benefit of the society.

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Appendices

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Appendix 1: Understanding transactable assets in technology transfer

This appendix aims to explain some common terms used in the field of Technology Transfer such as technology, know-how, patent and other IP rights, and also remove some misconceptions that cause confusion not only in licensing discussions but also in the reporting of innovation outputs and outcomes.

Typically, the "assets" available for a transaction with an academic/ research organization include:

- Know-how: Know-how is essentially a recipe or knowledge on how to do a certain task or carry out a certain process or make/produce something useful. Certain aspects of a know-how may be protected by one or more patents, if at all. One can also have know-how that the know-how creator decides to keep confidential and not disclose any part of it (including by filing of patents, which result in public disclosure)
- Patent rights: A right to exclude others from practicing the art disclosed and protected in the patent.
- Others: This includes –
    - Other IP rights, such as copyrighted materials
    - useful data such as clinical data or protein structure databases,
    - physical collection of samples such as biobanks or microbial collections,
    - accompanying R&D capabilities

It is very important to point out that TTOs can have transactions that deal with any combination of the above "assets". For example, one can have an agreement featuring:

- Only know-how (even in the presence of related patents)
- Only patent rights (even in the presence of related know-how)
- Both know-how and patent rights

When a technology licensee approaches an academic/research organization, it will seek a one or more assets as a (let us call it) "transactable bundle" or in loosely referred to as a "technology".

It is a fallacy to:

- Expect one-to-one correspondence between a know-how and a patent
- Claim that every patent is a complete "transactable bundle" or "technology"
- Assume that a patent cannot be transacted without an accompanying know-how that the licensee wishes to practice

The "transactable bundle" or "technology" may comprise of one or more different parts depending upon the objectives of the licensee as illustrated in the table below:

Objective of licensee	"Transactable bundle" or "technology" comprises of:
Situation 1: • Know-how for carrying out a reaction A+B à D using a catalyst C • Rights to produce and use Catalyst C to practice the above know-how. • Rights to exclude others from producing and using the Catalyst C for carrying out the above know-how	• Know-how for carrying out a reaction A+B à D using a catalyst C • Exclusive rights to a patent protecting catalyst, C
Situation 2: • Know-how for carrying out a reaction A+B à D using a catalyst C • Rights to produce and use Catalyst C in order to practice the above know-how	• Know-how for carrying out a reaction A+B à D using a catalyst C • Non-exclusive rights to a patent protecting catalyst, C
Situation 3: • Rights to exclude others from producing and using the Catalyst C for carrying out the above know-how	• Exclusive rights to a patent protecting catalyst, C
Situation 4: • Know-how for carrying out a reaction A+B à D using a catalyst C • Rights to produce and use Catalyst C to practice the above know-how. • Rights to exclude others from producing and using the Catalyst C for carrying out the above know-how • Rights to freely transact the "technology" with others	• Know-how for carrying out a reaction A+B à D using a catalyst C • Exclusive rights to a patent protecting catalyst, C • Rights to sub-license know-how and patent rights freely, OR, Complete one-time transfer of ownership of "transactable assets"
Situation 5: • Know-how for carrying out a reaction A+B à D using a catalyst C • Rights to produce and use Catalyst C in order to practice the above know-how. • Rights to exclude others from producing and using the Catalyst C for carrying out the above know-how • Rights to new catalysts that the organization may come up with in the next 3 years	• Know-how for carrying out a reaction A+B à D using a catalyst C • Exclusive rights to a patent protecting catalyst, C • Exclusive rights to patents protecting catalyst, C1, C2, C3 etc developed in next 3 years (additional rights secured via a Sponsored R&D program for the next 3 years)

Table 16 : Examples of "Transactable Bundles" or "Technology" in licensing agreements

Appendix 2: Introduction to Intellectual Property

Intellectual property (IP) refers to creations of the mind, such as inventions; literary and artistic works; designs; and symbols, names and images used in commerce (as defined by WIPO).

In most countries/ regions around the world, IP is accorded the status of a property by law.

The scope and types of IP protected under the law and the extent of protection may wary from jurisdiction to jurisdiction.

It is important to understand that IP rights are country/ region specific and are valid only in the regions where IP was applied for and secured. Common types of IP are described in the table below:

Type of formal IP protection	Description	Relevant act
Patent	A patent is a right given to the owner of the patent to exclude others from practicing that invention for a limited period of time without the owner's permission. The right is provided by a Government in return for making the invention public and practicing it for the benefit of the people in the Government's jurisdiction.	Relevant act: The Patents Act (1970) and its amendments.
Copyright	Copyright is a protection that is given to creators for their literary and artistic works. Works covered by copyright include books, music, paintings, sculpture, films, computer programs, databases, advertisements, maps and technical drawings.	Relevant act: Copyright Act, 1957
Trademarks	A trademark is a protection that is given for signs capable of distinguishing the goods or services of one enterprise from those of other enterprises.	Relevant act: Trademarks Act, 1999 and its amendments
Industrial designs	An industrial design registration provides protection for the ornamental or aesthetic aspect of an article. A design may consist of three-dimensional features, such as the shape or surface of an article, or of two-dimensional features, such as patterns, lines or colour.	Relevant act: The Designs Act, 2000
Geographical indications	Geographical indications are signs used on goods that have a specific geographical origin and possess qualities, a reputation or characteristics that are essentially attributable to that place of origin.	Relevant act: The Geographical Indications of Goods (Registration & Protection) Act, 1999
Plant varieties protection	Plant Varieties Protection refers to legal protection for new plant varieties while also safeguarding the rights of farmers and plant breeders.	Relevant act: Protection of Plant Varieties and Farmers' Rights Act, 2001

Table 17: Common types of IP

Type of formal IP protection	Description	Relevant act
Circuit layouts	PCB layouts are protected in India through registration of the layout-design under the Semiconductor Integrated Circuits Layout-Design Act, 2000 at the Semiconductor Integrated Circuits Layout-Design Registry (SICLDR). This right protects against unauthorized reproduction and distribution.	Relevant act: Semiconductor Integrated Circuits Layout-Design Act, 2000
Trade secrets	Trade secrets are confidential information of the owner that can be used, disclosed or transacted only to the extent allowed by an agreement with the owner.	India does not have a separate law for trade secrets.

Table 17 (continued) : Common types of IP

The various intellectual property protections have been designed to ensure the following:

- Formal recognition of the creator as the original creator of the intellectual property
- Limited rights to the creator to prevent others from using the IP without the creator's permission. This provision ensures that creators can benefit economically from their creations.
- Public disclosure of the creative work as a public good available to others to advance the field and come up with newer creative works. This provision ensures that the creative work is not following the demise of the creator.

For academic and research organizations, the primary reason for securing intellectual property rights is to ensure the necessary protections that make the work more attractive to potential licensees. These protections offer a competitive edge, enabling licensees to confidently invest in and further develop the innovation, bringing it closer to achieving its full impact.

For TTOs in academic and research organizations, the most relevant forms of creative works and IP protections are given below:

Common forms of creative works	Formal IP protection in India
Inventions of compositions, processes, products etc	• Patents • Industrial design registration
Designs of products	• Industrial designs
Software	• Copyrights • Patenting possible with suitable implementation of software as a system
Proprietary data	• Trade secret • Copyright
Proprietary collections	• Trade secret
Books, research papers	• Copyrights
Teaching materials	• Copyrights

Table 18 : The most relevant forms of creative works and IP protection

Appendix 3: Introduction to Articulating Value Proposition

One of the most critical skills for Technology Transfer Professionals is the ability to identify, define, refine, and effectively communicate the value proposition of a technology developed by an inventor. Value proposition analysis is central to this process and plays a key role in:

- Uncovering the core sources of value embedded in an invention
- Assessing the technology's potential benefits and differentiators
- Identifying target customers or user segments who will value what the technology offers
- Clearly articulating the value proposition to potential licensees, buyers, or investors

Value Proposition Analysis is a strategic process used to identify how a product or service delivers unique value to its target customers (in comparison to other alternative solutions available to the customer). One of the most widely used tools to conduct this analysis is the Value Proposition Canvas (VPC), developed by Alexander Osterwalder.

Here is a primer based on the experiences of the Venture Center on how Tech Transfer Professionals can put a VPC to good use:

- Most TTOs will receive inventions that they need to understand.
- The first task is to understand/ imagine an end product/service that would emerge from the use of the technology.
- One can then put down technical features of the end product/ service, especially those that are reasons for creating new value for a potential customer of the end product/ service.
- The next task is to identify potential customer segments and personas that may be interested in the end product/ service.
- The VPC starts with identifying the following:
    - Customer side:
        - The target customer segment for whom this analysis is being done
        - The outcomes that this customer segment wishes to achieve using products of the kind that the inventor envisages.
    - Product and services side:
        - The end product/ services that is intended/ visualized
        - The alternative solutions that customer segment has to accomplish the same goals as the end product/service will help accomplish
        - A comparison of benefits (and not features) the invented product/ service vs other alternatives available
- The best way to do a VPC is to do only one customer segment and one product at a time. If there are multiple customer segments, then one ends up doing multiple VPCs – one for each customer segment.
- The above exercise immediately reveals the following:
    - Customer side:
        - Pains: These are negative experiences, risks, or obstacles the customer segment feels when trying to achieve their desired outcomes in status quo
    - Product and services side:
        - Pain Relievers: These are benefits arising from features of the product that describe how the product or service alleviates specific customer pains.
    - Fit between the two sides: If the value proposition is strong, then one would like to see a good match and fit between the pains and the pain relievers, with the most important pains being addressed extremely well.
- The VPC exercise continues further to explore if there were any other gains from the product/service that came as a by-product.

- Customer side:
  - Gains: These are the positive outcomes or benefits for the customer segment that came along unexpectedly or additionally.
- Product and services side:
  - Gain creators: These are benefits arising from features of the product that accrues to the customer segment bundled along with the main pain relievers and results in unanticipated gains for the customer segment.
- Fit between the two sides: Again, it is always desirable to have a good match and fit between the gains and the gain creators.

- The goal of value proposition analysis is to achieve "fit" between the Product side and the Customer side. A good fit occurs when: a) The products and services address important customer jobs, b) Pain relievers directly resolve significant customer pains, c) Gain creators deliver expected or surprising customer gains. This alignment ensures the offering is not only relevant but also compelling and differentiated from competitors.

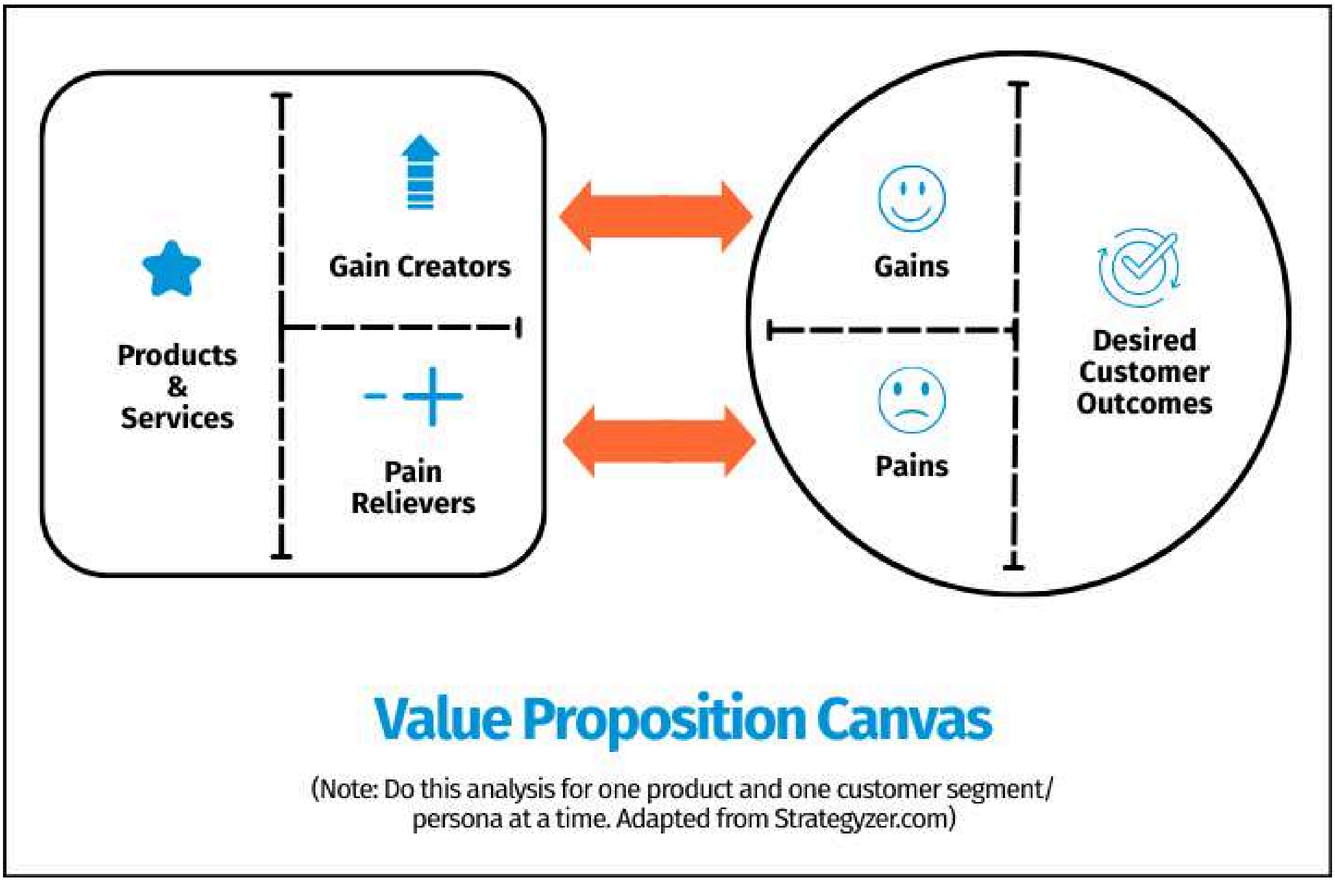

Figure 8: Value Proposition Canvas

Appendix 4: Introduction to Lead Development and Sales Funnels

Marketing and sales of any customer offering (product, service or bundle) has shared principles and common processes that can also be applied to technology marketing and sales as well. This Appendix briefly discusses some terminology and methods used by the larger marketing and sales community.

Lead Development is the process of identifying, engaging, and nurturing potential partners—such as customers, collaborators, licensees, investors -- who may be interested in a particular customer offering or technology or innovation. This is a critical part of the business development process.

To structure and manage this process, the Sales Funnel (also known as the sales pipeline) is often used.

This funnel represents the stages a lead goes through —from initial awareness to final conversion (such as a sale, partnership, license agreement, or investment).The funnel model tracks and over time quantifies what proportion of the leads convert – and that helps business developers plan the scale of their outreach efforts. The funnel helps the business developer track the status of leads systematically and pursue them. The funnel also helps identify where leads are getting stuck and refine messaging. Finally, an awareness of this methodology is important since the sales funnel methodology is embedded into modern Customer Relationship Management software which are used by many business developers.

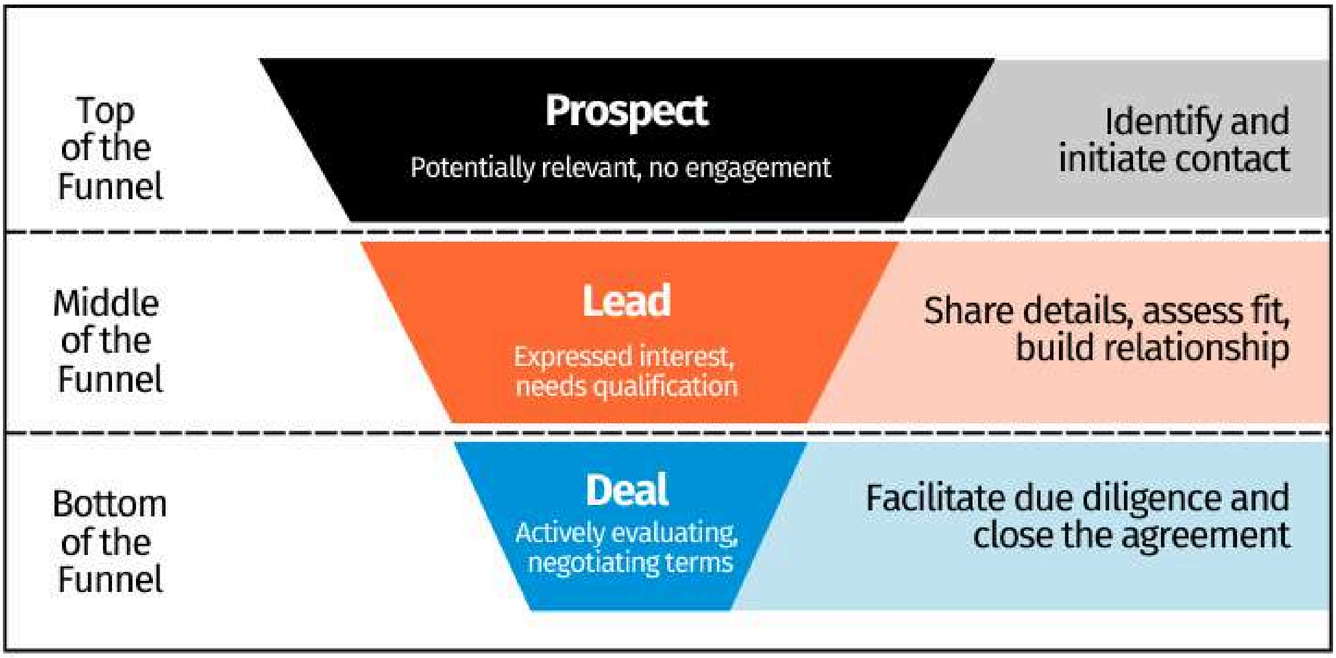

Figure 9: Sales Funnel

Note: The tabular representation contains data similar to the infographic mentioned previously.

Stage	Term	Status	Business Action
Top of Funnel	Prospect	Potentially relevant, no engagement	Identify and initiate contact
Middle of Funnel	Lead	Expressed interest, needs qualification	Share details, assess fit, build relationship
Bottom of Funnel	Deal/Opportunity	Actively evaluating, negotiating terms	Facilitate due diligence and close the agreement

Table 19 : Sales Funnel

At the Top of the Funnel, the goal of the marketing and sales person is to identify companies and individuals who might be interested in what is on offer. These are called prospects.

Prospects who show some level of interest move into the middle of the funnel. A lead is a prospect who has shown interest—they've responded to outreach, asked questions, requested info, or agreed to a meeting. The aim here is to:

- Qualify the lead by assessing their fit, capacity, and intent,
- Provide additional technical or market information,
- Engage in dialogue, answer questions, and build relationships,
- Coordinate meetings or calls with technical or domain experts.

When a qualified lead begins discussing terms, conducts due diligence, or enters negotiation, they become an opportunity or deal and enter the Bottom of the Funnel. Key actions include sharing confidential data under NDAs (if appropriate) and discussing deal structures. Only a small percentage of initial leads make it to this stage, which is why lead development must cast a wide but focused net at the top.

Appendix 5: Glossary of Terms

Term	Definition
Assignment Agreement	An Assignment Agreement is a legal contract through which the ownership of intellectual property (IP) rights is permanently transferred from one party (the assignor) to another (the assignee).
Biodiversity Act	An Indian law enacted to ensure the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising from the use of biological resources and associated traditional knowledge.
Cleantech (Clean Technology)	Technologies that improve environmental performance, reduce emissions, or promote energy and resource efficiency.
Conflict of Interest	A situation where an individual's personal or financial interests could compromise institutional responsibilities or objectivity.
Consortia Mode Development	A collaborative R&D model where multiple organizations jointly develop technologies of shared interest.
Deal structure	A Deal Structure refers to the framework and key terms that define how a transaction or agreement is organized, including the allocation of rights, responsibilities, financial arrangements, and risk-sharing between the parties involved.
Exclusive license	A legal agreement in which the owner of an intellectual property (IP) grants exclusive rights to a single licensee to use, produce, and commercialize the IP within a defined scope—such as a specific field, application, or territory. Under this arrangement, no other party, including the licensor, may exercise those rights during the term of the license, while ownership of the IP remains with the licensor.
Foreground IP	Intellectual property created or developed during the execution of a project or collaboration, arising directly from the activities carried out under that initiative. It is distinct from background IP and is typically governed by the ownership, access, and exploitation terms defined in the project or collaboration agreement.

Term	Definition
Field of use	Field of Use refers to the defined scope or application area within which a licensee is permitted to use, develop, or commercialize an intellectual property (IP) under a license agreement. It establishes boundaries for the authorized use—such as specific industries, products, or markets—while allowing the licensor to retain rights in other fields or applications.
GAP Funding (Proof-of-Concept Funding)	Financial support provided to bridge the gap between academic research and market readiness by de-risking innovations.
Impact Metrics / Technology Transfer Wheel	A reporting framework (developed by AUTM) that visualizes TTO inputs, outputs, and impacts such as patents, licenses, and startups.
Invention Disclosure	The first confidential record submitted by an inventor to the TTO describing a potentially patentable or commercially viable innovation.
Intellectual Property	Legal rights protecting creations of the mind, including patents, trademarks, copyrights, industrial designs, and trade secrets.
Intellectual Property Policy	Institutional document defining ownership, protection, disclosure, and benefit-sharing mechanisms for IP created internally.
IP administration	The systematic management of intellectual property (IP) assets within an organization or jurisdiction. It involves the processes, policies, and structures used to identify, protect, maintain, monitor, and commercialize IP rights.
IP Ownership	It refers to the legal right to control, use, and benefit from an intellectual property (IP) — such as an invention, design, trademark, copyright, or trade secret.
Knowledge Exchange	The broader process of sharing and applying knowledge between academia and industry through consulting, joint R&D, or licensing.
Licensing	Licensing is a legal arrangement in which the owner of an intellectual property (IP) grants permission to another party to use, make, sell, or distribute the IP under agreed terms and conditions, while retaining ownership of the IP
Licensing Agreement	A legal contract where an IP owner grants another party the right to use the IP under specific conditions.

Term	Definition
Licensee	A licensee is the individual or organization that obtains rights from an intellectual property (IP) owner (the licensor) to use, produce, or commercialize the IP under the terms of a license agreement.
Licensor	A licensor is the individual or organization that owns an intellectual property (IP) and grants rights to another party (the licensee) to use, produce, or commercialize it under a formal license agreement, while retaining ownership of the IP.
Limited Exclusivity License	A license agreement that grants exclusive rights to a licensee within a defined and restricted scope, such as a specific geographic area, market segment, product line, or application, while allowing the licensor to retain or grant rights in other areas.
Materials Transfer Agreement	A contract that defines the terms and conditions under which tangible research materials such as biological samples, chemical compounds, or data) are shared between organizations or individuals
Mission Mode Program	A government or non-profit initiative focused on solving large-scale societal problems through coordinated R&D collaborations.
Non-Disclosure Agreement (NDA)	A legal contract that ensures proprietary or unpublished information shared between parties remains confidential.
Non-exclusive License	A license agreement that allows the licensor to grant usage rights to multiple licensees simultaneously, enabling each to use, produce, or commercialize the intellectual property (IP) under agreed terms.
Open Innovation	An approach where organizations use both internal and external ideas or technologies to accelerate innovation and commercialization.
Options Agreement	An Options Agreement is a contract that grants a party the exclusive right, for a defined period, to evaluate an intellectual property (IP) asset and decide whether to acquire a license or other rights to it under predetermined terms.
Patent	An exclusive legal right granted for an invention that is novel, useful, and non-obvious, typically valid for 20 years from filing.

Term	Definition
Patent Analytics	The systematic analysis of patent data to assess novelty, trends, competitive positioning, or potential collaboration partners.
Patent families	Patent families are groups of related patent applications that cover the same invention and are filed in multiple countries or jurisdictions.
Proof of Concept	Experimental evidence that demonstrates an idea or invention works as intended in principle.
Proof of Value Study	Validation that demonstrates a technology's comparative advantage or market potential beyond its technical feasibility.
Raison d'être	It is a French term that literally means "reason for being." It refers to the fundamental purpose or justification for someone's or something's existence
Revenue Sharing Policy	Institutional rules that define how income from IP commercialization (royalties, fees, equity) is distributed among stakeholders.
Seed funding	Seed funding is the initial capital provided to a startup or project to support early-stage development, such as proof of concept, prototype creation, or market validation.
Spin-out / Start-up	A new company created to commercialize technologies or inventions originating from academic or public R&D institutions.
Technology Assessment	The evaluation of a technology's novelty, readiness, IP strength, market potential, and impact.
Tech brief	A Tech Brief is a concise, informative document that summarizes the essential details of a technology, including its concept, key features, advantages, potential applications, and intellectual property status. It serves as a communication tool to present the commercial relevance and partnership opportunities of the technology to prospective investors, collaborators, or licensees.
Technology Marketing	Activities focused on identifying, promoting, and positioning research outputs for industrial or investor partnerships.
Technology Readiness Level	A 9-level scale used to assess a technology's maturity—from concept (TRL 1) to commercial deployment (TRL 9).

Term	Definition
Technology Readiness & Translation Fund	Institutional or government funding used to advance promising innovations from research to market.
Technology Transfer	Technology transfer is the process of moving industrially useful knowledge created in academia and research institutions and putting it to practical use in industry and start-ups for producing products and services that can eventually deliver socio-economic impact for society
Technology Transfer Office	A specialized unit within a research or academic institution that manages IP, commercialization, and partnerships.
Technology Transfer Professional	A trained individual responsible for managing IP, evaluating inventions, negotiating deals, and building collaborations.
Technology Translation	The process of advancing a discovery toward application through prototyping, validation, and scale-up.
Technology Valuation	Estimation of the economic worth of a technology for licensing, negotiation, or investment purposes.
Transactable Asset	A tangible or intangible research output (e.g., patent, prototype, dataset) that can be transferred, licensed, or sold.
Value Proposition	A Value Proposition is a clear and concise statement that articulates the unique value, benefits, or advantages offered by a product, service, or technology to its intended users or market. It explains how the offering addresses a specific need or problem and why it is superior to existing alternatives, thereby defining its core appeal and competitive advantage.
Valorisation	The process of enhancing the practical or commercial value of research outputs through development and adaptation for market use.

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