Guidelines

Knowledge Translation Research

2022

Prof. Rajan Gurukkal

Vice Chairman

The Kerala State Higher Education Council

Prepared For Project

Translation Research

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Contents

Preface

In recent times there has been an increasing pressure on Higher Education Institutions (HEIs) for a reorientation of their research sector as to be capable of transforming knowledge into uses, services, property and products. It is a dynamic process involving ideas, external relations, communication and collaboration with multiple agencies for joint actions. The Government of Kerala has set apart a considerable amount for translation research, incubation and startups.

A comprehensive description of Knowledge translation defining its meaning, mechanisms, methods, and measures is much wanted in the field of research across disciplines. It is indispensable to collate ideas drawn out from the extant literature and formulate a standard definition useful for researchers in all domains of knowledge.

The principal objective of this Guidelines Document is to explain what Knowledge Translation means and to help identify a feasible knowledge translation framework that enables systematic implementation in the domain of the General and Professional Higher Education Institutions.

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Vice Chairman

Introduction

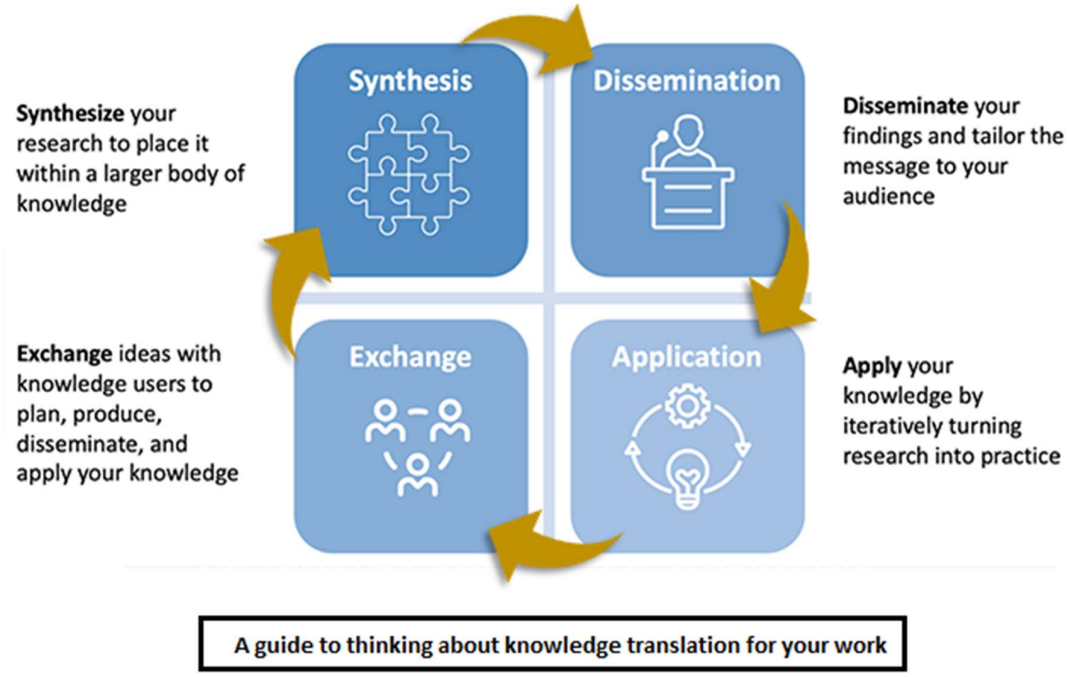
The principal objective of this Document is to describe Knowledge Translation (KT), help identify a feasible KT framework, and enable its systematic implementation in the Higher Education Institutions (HEIs), both general and professional.

A comprehensive description of (KT) defining its meaning, mechanisms, methods, and measures is much wanted in the field of research across disciplines. Collating ideas drawn out from the extant literature, this document, to some extent, serves the purpose of formulating a standard definition useful for our HEIs and the researchers in all domains of knowledge.

In the simplest form KT means putting knowledge to productive uses. Always knowledge has been in use for quality decision making, but what we mean by KT in the present context is different. It means the institutionalised, professional and iterative way of transforming knowledge into services, products and property. It involves a smooth but complicated relations of exchange of needs and ideas between the people (the consumers of knowledge) and the researcher (the producer of knowledge), facilitating translation of knowledge into uses of ethical justification. In short, KT signifies a judicious action to turn research outcomes into practice, a dynamic and iterative process of linking knowledge with its application; yielding products, services and intellectual property.

KT is a dynamic process of interconnected decisions and actions. Its key components are: knowledge production, synthesis, contextualisation, adaption, dissemination, exchange and ethically sound application. What makes KT

unprecedentedly enterprising today is the context of the Knowledge Economy (KE) that has embraced the world. It has made knowledge the basic economic resource and the acquisition of it the most important economic process.



Knowledge Economy Context

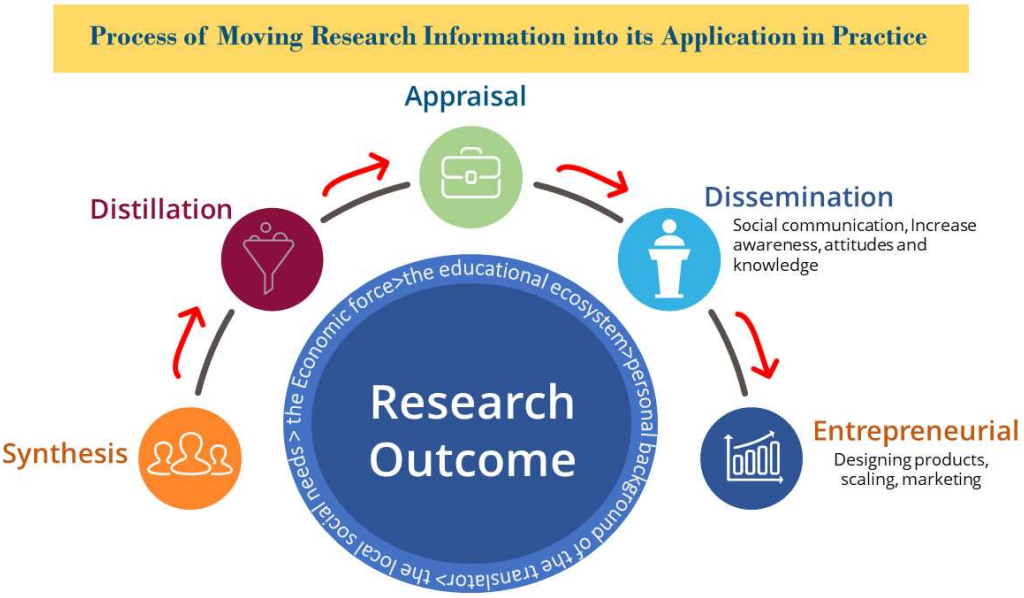
We cannot historicise KT beyond the Industrial Revolution. A concern for the nature of knowledge and methodological preoccupation for making it reliable with the primacy of evidence dates back to the early Indian logical tradition and classical Greek philosophical systems. Indeed, inventions had always been there intertwined with ‘necessity and chance,’ to borrow the expression in evolutionary biology coined by a Nobel laureate, Monod (Jaques Monod, 1972).

Conscious efforts to carry knowledge forward to products happened phenomenally during the Age of Industrial Revolution. Sustained over the 19th and 20th centuries in tune with the expansion of knowledge into multiple fields of specialisation, production of knowledge leading to discoveries and inventions acquired a higher dimension during the two World Wars (R. Gurukkal, 2019). The leading institutions of technology and Departments of Science in some universities were required by the political power to involve in the task.

KT of the institutionalised kind began in the health sector by evolving its own frameworks of comprehension and praxis (Backer, 1991; Lane & Flagg, 2010; McKibbon et al., 2010; M. Barwick, R. Dubrowski & K. Petricca, 2020). However, KT was not an item of so much importance in the plan of action of Higher Education Institutions till the Recession of 2008 that set in the rise of the industrial production of knowledge and its uses for capital accumulation, identified as KE, the latest version of Capitalism (A. Feenberg, 1991; M. Perelman, 2003; L. Suarez-Villa, 2000; 2009; and 2012).

Information Economy (IE) that focuses on information or data, quite crucial for the working of the knowledge-driven society, is another dimension of KE. IE is not producing knowledge but generating, storing, processing, communicating, exchanging and consuming information or data by using digital technologies. What it demands the most is the tacit form of knowledge (skill), essential to operate digital technologies. KT is heavily dependent upon IE and Information Communication Technology (ICT), the basic tool of the knowledge-driven economy and its macro field of multiple enterprises.

KE uses knowledge as Intellectual Property of enormous exchange value as a commodity by itself. As a potential basis for the production of other commodities it is capital too. KE is capital and technology-intensive industrial mass production of marketable knowledge, presupposing precedence of innovation over discovery. It makes industry a heavily knowledge based establishment combining scientists,



engineers and information workers. Higher education institutions, particularly universities and research centres, engaged in production and transmission of

knowledge, have now become integral to the KE, which constrains them to be repositioned as institutions of KT.

Problems

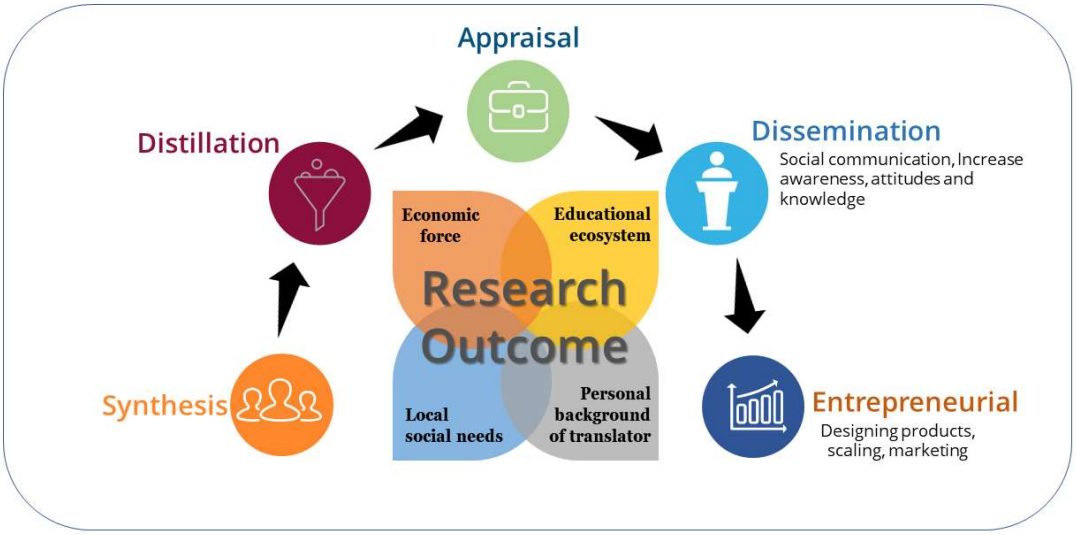
Knowledge has been growing in response to the development needs though its production and transmission largely take a straggling course. Entrenched as part of obsolete education, production of knowledge almost ceased in many universities due to the degeneration of research as mere repetition of knowledge. Universities with affiliated colleges, functioning merely as the secretariat of centralised examinations, have played a major role in the process.

Repeating obsolete knowledge, most universities in the Country are long way off from their globally ordained primary function — production of new knowledge and its transmission. Naturally there is a commendable gap between research and practice. Our first task is to address the gap between knowledge production and transmission and then the gap between the knowledge and its translation. Removing these gaps involves a series of strategic moves. Revamping the existing set up of higher education in general and transforming the perception and objectives of research in particular are the tasks thereof.

There are economic, socio-political and cultural gaps. The economic gap refers to the fundamental systemic gap from which the socio-political and cultural gaps ensue. Our economy is yet to evolve itself into a further advanced system that commands production of marketable knowledge and demands its translation for exchange. In the milieu of a relatively satisfactory material condition, the policy initiative, inherently top

down though, would accentuate the evolutionary process. India's current policy initiatives under the National Education Policy 2020 and Kerala's efforts towards higher education empowerment underscore the increasing recognition of the need for revamping the higher education and redefining the context as well as the purpose of research.

Process of Moving Research Information into its Application in Practice



Concepts, Theories, Frameworks and Strategies

KT professionals are proficient in concepts, theories, frameworks and strategies (CTFS), which help understand what KT means and how it works. It is necessary for the beginners to know the concept and theories for organising the setup of KT (N. Amara, M. Ouimet & R. Landry, 2004). As such there is no specific theory of KT, independent of the contemporary means, forces, relations and exchange coming under political economy and social theory, which have a top-down liberal perspective as well as the bottom-up critical perspective.

The liberal neoclassical political economy and microeconomic theories, globally dominant, do matter in KT researches generating proofs for iteration of entrepreneurial and industrial interest. Theories of KT relate to factors and contextual variables of interventions with the implementation of knowledge and its use in practices (M. Barwick, R. Dubrowski, & K. Petricca, 2020). They provide explanatory guidance for knowledge translation activities. We need theoretical insights into the basic questions like what knowledge should be translated, to which form, how, through whom, and for whose benefits. In the theoretical perspective of political economy, knowledge translation is a way to contextualise the transfer of knowledge from its source to the receiver and to interpret the knowledge to be exchanged.

There are a few contextual frameworks with some common constituents and sorting categories. They seldom last long. They are not empirically supported to be sure about its reliability. Strategies are empirically grounded, realistic, comprehensive, and appropriate to the context of knowledge creation and translation (W.N. Dunn, 1983;

T.E. Backer,1991). CTFS thus refer to a set of concepts, microeconomic theories, their political economy, frameworks and practical strategies.

Strategies

KT strategies start with the preparation of the conditions essential for filling in the gaps between research and translational outcomes. It necessitates to reconstitute the prevailing system of higher education into a system with all mechanisms and methods, which guarantee a strong research sector famed for outcomes amenable to translation. How to bridge the gap between knowledge and practice is the most basic strategy that KT needs. It is the strategy of making research inevitably problem solving. KT strategies facilitate the process of putting research outcomes to applications. Strategies enable utilisation of knowledge and iterative evidence in various practical contexts and situations (J.K, Larsen, 1980; J. Knott, & A. Wildavsky, 1980; W.N. Dunn,1983).

A strategy must be primarily for evolving mechanisms, methods, and means for reorienting the research ecosystem with a view to facilitating production of knowledge

amenable to application. Making research issue based, curiosity driven, and solution centric is the first indispensable step under the strategy. Issue based research (IBR) leads to the production of applied knowledge (PAK). This helps frame research questions, formulate hypotheses, and choose methodology as a mutually reinforcing package that guarantees problem solving outcomes. Abroad but crucial strategy should be to integrate production, diffusion and utilisation of knowledge as a policy of practice in decision-making contexts.

Making research innovative is the next strategy. Any serious research of theoretical outcomes comprises discoveries that explain causes and consequences. KT driven research has to be inevitably practice-oriented and innovative. It necessitates the strategy of transforming theory into praxis i.e., transforming discoveries into inventions.

A stumbling block in the research domain of most universities is its rigid disciplinary segregation. As CP Snow observed (The Two Cultures, 1959), there exists separation not only between science and arts but also between science and technology. He diagnosed the loss of a common culture with the emergence of a distinct academic worldview of science distinguished from that of human sciences and liberal arts. He hated this cultural divide between science and arts — the two great areas of human intellectual activity. Snow wished if the practitioners in both areas could draw closer to one another furthering the progress of human knowledge for the benefit of society.

Cross disciplinary communication is extremely important for KT because social interaction is indispensable for it. A systematic removal of disciplinary segregation in

learning and a gradual entrenchment of interdisciplinary research through a total curricular revamping is the crucial strategic step towards KT.

Cross-disciplinary Dialogues

KT driven researches being invariably problem specific, cannot stick to any particular discipline. Further, human problems have no disciplinary identity. Naturally disciplines converge in KT researches that always proceed across disciplines. KT demands convergence of sciences, human sciences, arts, and technologies; which enable holistic contextualising of the problem and sustainable solution guaranteeing discoveries.

Cross-disciplinary dialogues sustain reciprocity between researchers and their beneficiaries, who include various agencies big and small discharging different functions from production of new knowledge, circulation of research outcomes, their translation into products, the technological mediation of production, and commercialisation of the use-context to the exchange of products.

Communication with the general public is central because KT is heavily dependent on identification of social needs, dissemination of knowledge, popularisation of its socially useful aspect and expansion of its public utilisation (J. Knott, & A. Wildavsky, 1980). Basically, an interactive process necessitating exchange of ideas, the multidirectional communicative strategy is what KT has to sustain all along.

As new knowledge accrued over centuries, specialisation got diversified at the expense of holistic understanding. Academics of disciplinary specialisation sought to resolve the problem through multidisciplinary research. But an approach that just

gathers multiple disciplines around one problem of study, 'multidisciplinary' hardly made any difference since the perception remained basically disciplinary. Interdisciplinary approach as a movement of convergence research proved to be the most successful in facilitating holistic comprehension of social reality.

Interdisciplinary research moves across disciplines, their interfaces and beyond enabling production of knowledge that is regenerative, non-conventional and resolution oriented. Many people think 'multidisciplinary' and 'interdisciplinary' are the same and hence they use the two terms interchangeably. The definition of Roland Barthes (French Literary Theorist) is worth reproducing here: "Interdisciplinary work, so much discussed these days, is not about confronting already constituted disciplines none of which, in fact, is willing to let itself go. To do something interdisciplinary it is not enough to choose a subject (a theme) and gather around it two or three sciences. Interdisciplinary consists in creating a new object that belongs to no one." (R. Barthes, 1986).

Conceptualisation

All knowledge forms, though important in their own right, need not be amenable to translation. Certain research outcomes may be of no translational value at all. A good chunk of theoretical material generated through research, has enormous potential in the context of translation. In most cases there is a serious gap between theoretical knowledge and its use. This is being increasingly recognised as the distance between theoretical knowledge and practical social needs. Filling in the gap needs concerted efforts by way of extensive research, a subject widely talked about today as Translational Studies.

Conceptualising the process, we discern KT as a combination of linear and non-linear processes. A linear translation of knowledge (LTK) refers to research outcome and its use forming a single running thread. It is production of knowledge ready for application presupposing no gap between the research outcomes and their use. Researches in such cases are problem driven and their outcomes are inevitably solutions. Knowledge directly becomes a product or service or process of social use implying entrepreneurial and industrial involvement. Hence LTK is the optimal condition of KT. Engineering, characteristically a process of issue based inventive exercise of trials and errors, constitutes a conducive field LKT.

A gap that has to be addressed immediately is the one existing between researchers and the larger public, who await translation of knowledge. Translation of theoretical knowledge into useful goods and services involves a non-linear course of research comprising trials and errors (A.H. Van De Ven, 2006). A commendable body of

theoretical knowledge exists as a huge domain accessible through numerous potential sites of sciences and technologies.

Engineering and technology represent the most productive domain of LKT. Although often made out to be dependent on discoveries of sciences, both engineering and technology are autonomous fields of production and translation of knowledge. They yield endless inventions under the pressure of necessities. However, we owe most discoveries and inventions to chances too.

Evidence Based Iterative Production

Discoveries and inventions enable evidence based iterative production (EBIP) of goods and services. In our regional as well as national context EBIP is of great importance. EBIP is what most Start-Ups do as KT in the technology sector. Very few higher education institutions in the Country are active in KT. This must change. All the higher education institutions of engineering and technology besides some of the Science Departments of universities must have Start-Ups for FBIP. Each of them must have a Cell to coordinate KT activities by engaging the genuinely interested students under the scheme of Earn While You Learn (EWYL).

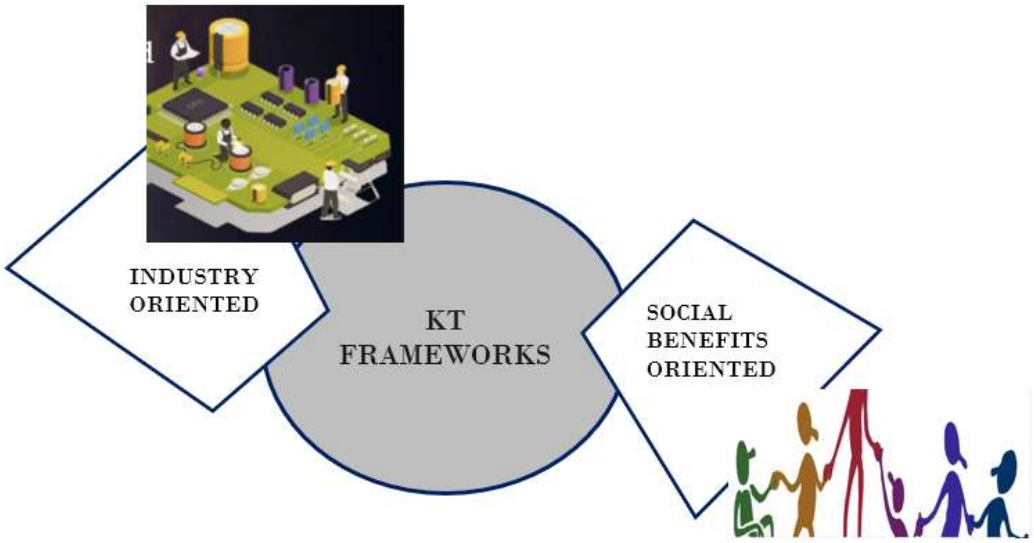
Students and teachers have to engage in multidisciplinary dialogues with the local people to ascertain the social needs and contexts of cross disciplinary nature for self-engagements of reciprocal help. Similarly, they have to interact with the industries as well. Industries scale up evidence-based design and production of goods and services. All the higher education Institutions have to design interdisciplinary projects

and build up ties with entrepreneurial establishments and industries for reciprocal benefits.

Non-linear KT requires sustained researches in theoretical knowledge for generating evidence of iterative value, which is highly essential for reducing the gap between research outcome and KT. The advancement of KT depends on the increasing scope of EBIP, which attracts entrepreneurs, who mediate with technology for designing products and building up their industrial manufacturing. All this necessitates awareness of the process and mechanisms for expanding research to generate evidence for the growth of EBIP.

Frameworks

Frameworks are important for conceiving how to expand through what stages, with which components, where, when and how. They enable the institution to make the best use of KT opportunities through efficient communication, fruitful interactions, and successful partnerships for attaining the postulated goals. Centres and the researchers can engage in KT processes. A potential KT framework is the one that balances between the macro policy of the institution and the micro project of the individual researcher.



Global KT frameworks (GKTFs) based on a research cycle is generally used as a conceptual guide for the overall KT process. GKTFs underline three components — interactions, communications, and partnerships — vital.

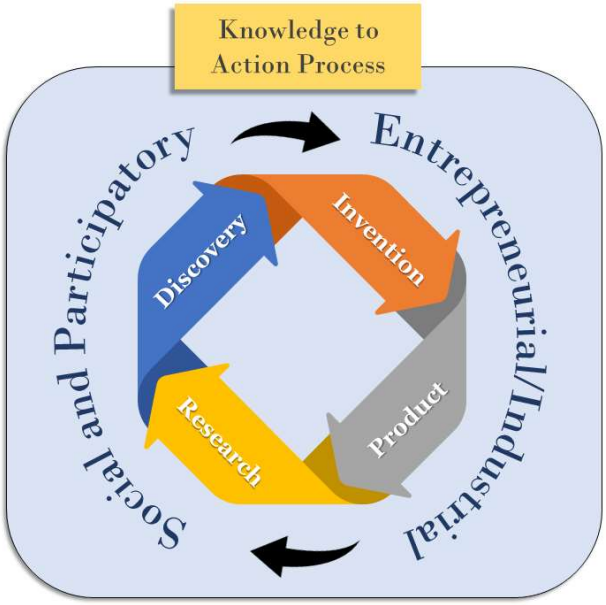
A full-spectrum GKTFs passes through the following four sequences: a) identification of specific problems, b) locating the knowledge base, assessing the gap, c) engaging researchers, d) inventing the solution. Issue based Research, Production of knowledge, Designing Products and circulation among Users are part of the process. Similarly, Evidence Review to form the idea of products, Design practices/uses, and Planning circulation are integrated too. Specifically, this framework can be used as a guide for establishing interactions required in the KT process. For our convenience, we can broadly group KT frameworks into Social Benefits Oriented (SBO) and Industry Oriented (IO).

This grouping does not mean that the two categories are mutually exclusive. Actually, the two significantly overlap in their operation. They are different in primacy of objectives that can be separated in terms of binaries such as public >< private;

Government >< non-Government; unselfish >< selfish etc. Of the SBO group the most effective is the Participatory Framework.

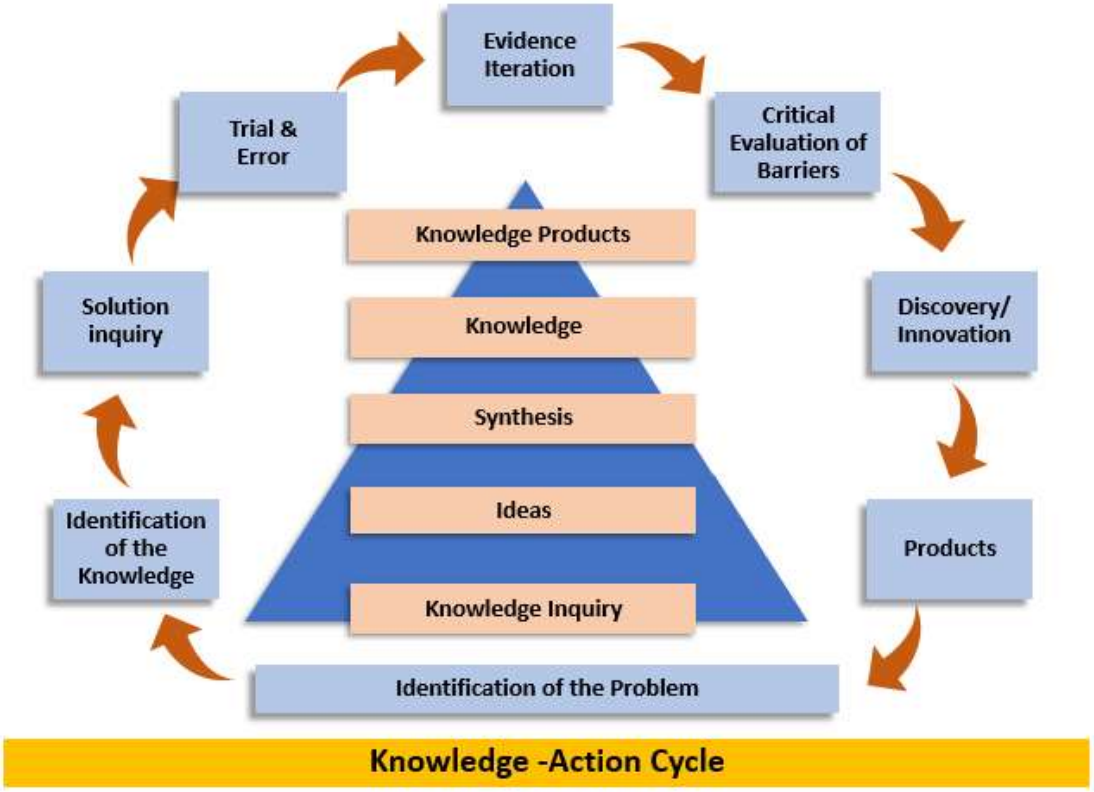
a) Participatory Framework

One of the most vital frameworks of KT is the one based on social participation (Horowitz C, M. Robinson, S. Seifer, 2009). Participatory Framework at once denotes people's participation at different levels — at the level of research as well as at the level of devising uses.

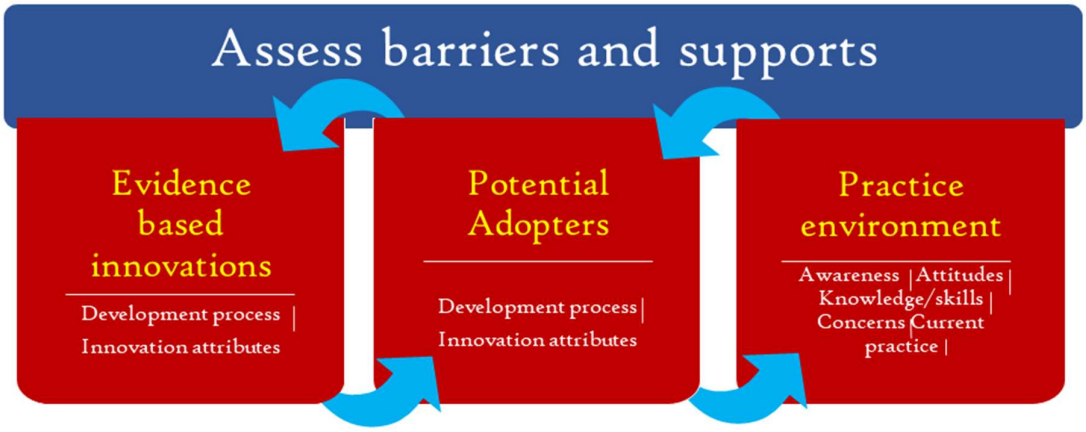


It denotes a functional transposing at both ends — the researchers' end as well as the people's end. People do the researchers' function as facilitated by the researchers and vice versa. People undertake research to discover the solution for the problem they encounter. This involves researchers' sharing of the relevant knowledge with the people and enabling their participation in research. Such a joint operation by researchers and people in identifying social needs and discovering solutions to cater

to them removes the gap between knowledge and its uses rapidly and resource frugally. Sometimes people find solutions to their problems if researchers facilitate it. In certain cases, the researchers find solutions to social problems facilitated by the people. This is the process of integrating research outcome for the people to use it for finding solutions to their problems (A.M.Y. Drahota, et al. 2016; V. Kaputa et.al, 2022; C. Păunescu, et.al eds.).



Establishing links between knowledge and its use is best attained through participatory research in which researchers, knowledge disseminators and beneficiaries work as a team. Universities can practice this by encouraging local people's participation in knowledge translation research for social benefits.



Increasing familiarity with and understanding of the intended user groups are very important for the Participatory Framework. It requires an array of questions enabling a successful link with the people. Questions should help the researchers to be sure of what they already know about the people and their needs. Questions should also help identify the still unknown facts about the needs. It is important to frame the questions effective enough to understand multiple aspects of the people, their awareness of issues to be resolved, attitudes towards research, access to information sources, operational channels, decision-making institutions, and experience in knowledge translation practices. Some of the crucial questions are: What do the people know about their issues and how do they currently try to resolve them? What expertise do the people need for a better understanding of their issues and how to orient them towards translation research? Do the researchers and the people have experience in working together?

Dependent upon the understanding of the various aspects of the people strategies have to be evolved for preparing their minds for translation efforts. To a certain extent the questions of the researchers would be useful for creating public awareness of translation process. For a proper awareness, it would require interactions,

discussions, circulation of written material, and various other means of information dissemination including multimedia communication. Actually, the success of Participatory Framework depends on the depth of mutual understanding between the knowledge producers and knowledge consumers.

b) Industry Oriented Framework (IOF)

In IOF the industry plays the decisive role in the KT process of decision making and implementation. It controls the KT constituents such as knowledge production, synthesis, contextualisation, adaption, dissemination, ethically sound application, commercial manufacturing and exchange. Industrial attraction is always towards evidence-based innovations of productive potential (R. Landry, N. Amara & M. Lamari, 2001; J.P. Lane, & J.L.Flagg, 2010). A potential innovation will have many adopters. Therefore, industries encourage research outcomes to be innovative and amenable to implementation.

Industries often involve in the research process from the beginning to the end if they are convinced of its innovative potential (R.M. Lee, Y. Yuan, 2018; N. Gleason ed.). They make sure that the research outcome is relevant to their needs and can be applied productively and profitably in the shortest possible duration. Knowledge translation (KT) being an iterative process, industries make sure that it enables evidence-based replication.

An industry is systematic about the process of monitoring, and assessing each aspect before, during, and after the adoption of an innovation for commercialisation. Its primary concern is profit maximisation and sustainability. Hence the industry takes care of quality, safety, efficiency, and costs of products besides their sales

maximisation. In relation to these industries give importance to the knowledge consumers as well.

IOF is also called knowledge-to-action framework (KTAF), for it means the linear process of turning research outcome into goods and services catering to the needs of entrepreneurs, traders, policymakers, and the general public. The KTAF has only two components: 1) Knowledge Creation and 2) Action. Both components presuppose certain phases, independent, simultaneous, and sequential influencing one another. How to participate in the process should be what the Higher Education Institutions have to seek.

Medicine and Engineering Institutions

KT literature, theoretically weak though, mostly deal with frameworks, methods, and strategies drawn from the field of medicine and rehabilitation. Very few deals with engineering. However, KT is somewhat different in professional institutions compared to that of a few universities where efforts towards bridging the gap between research outcomes and their social or industrial utility are under way.

What matters in medicine and rehabilitation, a domain of higher education dedicated to production of practitioners through training, is empirically observed practical evidence. It is not translation of knowledge but transfer of experience or dissemination of practices (L.S. Johnson, 2005). Therefore, KT means iteration of evidence-based practice rather than translation of research outcomes into products and services. KT in the real sense involves production of new knowledge and its translation into uses, i.e., research for knowledge amenable to practices. In fact, production of new knowledge is more important in medicine than in rehabilitation, for the latter needs better application of existing knowledge i.e., iteration of evidence-based practice and its dissemination (K. Kirkhart, & R.F. Conner, 1983).

The field of medicine is inherently interdisciplinary and bewilderingly vast as well as complex with numerous issues awaiting convergence research. Nonetheless, research in the field is abysmally poor in the country and nothing to talk about it in the case of the State. A medical university with multiple branches of specialised sciences with researchers of cross disciplinary adaptability for heavily collaborative researches can fruitfully engage in KT. In this research the industrial collaboration has enormous scope, while the chance of social participation is very limited. However, if applied

optimally the participatory framework can enhance people's ability to identify and resolve their issues. Above all people's involvement has the benefit of socialisation of knowledge with equity.

In the field of engineering, KT is both linear as well as non-linear transfer of tacit knowledge generated through trial and error. This activity has to be scaled up in a phased manner through the startup. A startup is the initial stage of an industry in the making but with definite objectives and evident potential. Many startups are in the field of medicine, agriculture, and engineering especially in software, growing towards industries. Focused on specific engineering ideas, startups translate them into marketable goods, mobilise market, develop exchange network, identify potential users and circulate the products.

Startups need support systems like Incubation Centres or Accelerators. This began significantly in the private sector HEIs of the country. Amity Institutions ventured in the field in 1990 starting Amity Innovation Incubator (AII) as part of its institutions. Followed by this a few public sector incubation and acceleration centres of startups built up by Higher Education Institutions like universities using the Government fund. Ahmedabad IIM's Centre for Innovation and Entrepreneurship (CIIE) stated in 2002 with the Government support is probably the first and best example. Society for Innovation and Entrepreneurship (SINE), founded by Mumbai IIT in 2004 for nurturing startups from planning to implementation, is another example. We need many more incubation-acceleration centres in the public sector for the proliferation of startups.

Many venture capitalists provide funding for startup accelerators in the country. Indian Angel Network (IAN) stared in 2006 by several experienced leaders in the

entrepreneurial ecosystem is an important Accelerator that provides funding and access to networks that help with frameworks, strategies and other inputs for innovative enterprises. Amity (AII) collaborates with IAN in its functions. The iCreate, opened in 2012 is a similar organisation famed for its methodology effective in sorting innovative startups for funding, technical advice, and opportunities to flourish as successful entrepreneurs. GSF Accelerators (GSFA), a tech-focused early-stage venture capital, founded in the same year is a firm that provides funding and mentoring to startups to scale their products and services. Cisco Launchpad (CL), an initiative by Cisco, Microsoft Accelerator, owned by Microsoft, Zonestartups, a joint venture between Ryerson University, Toronto and Stock Exchange Institute (BSE), Mumbai are other examples.

What HEIs Should Do

HEIs must urgently develop strategies for revamping the existing set up of higher education in general and the objectives of research in particular to fill the gap between their academic research and genuine knowledge production to reach translational knowledge. In the process they become capable of evolving mechanisms, methods, and means of reorienting the research ecosystem suitable for producing knowledge amenable to application.

Once they undertake issue-based research, they experience the process of putting research outcomes to applications and identify iterative evidence in various practical contexts and situations. They must undertake knowledge production, synthesis, contextualisation, adaption, dissemination, and exchange to experience the dynamic process of KT.

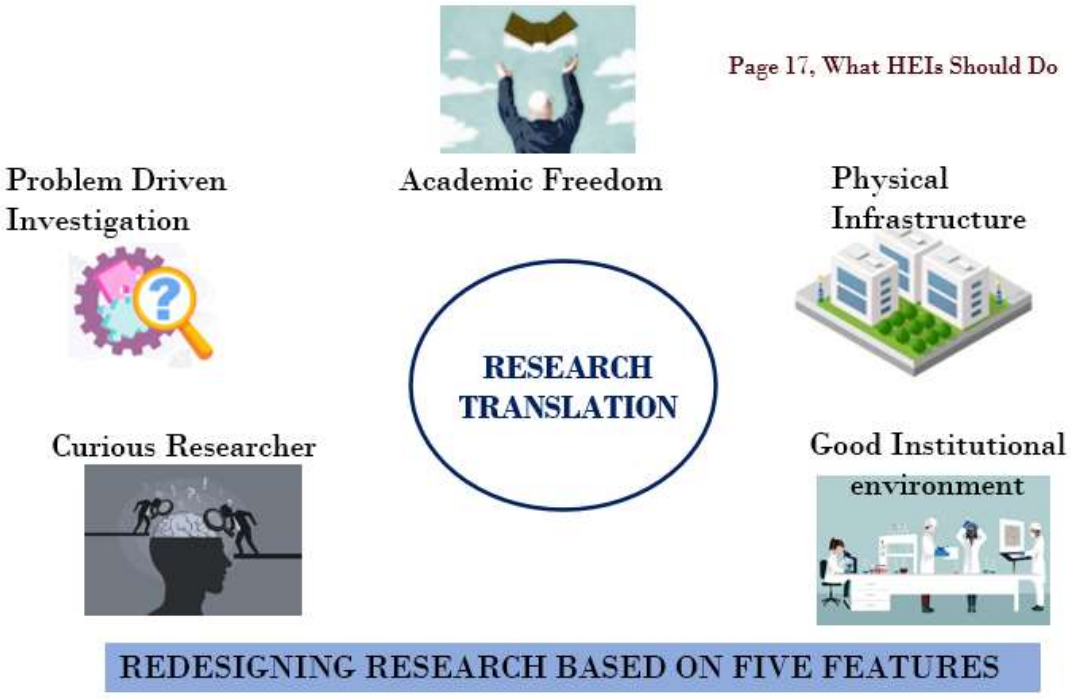
With the curricula revamped, disciplinary segregation avoided in teaching and learning, and the research sector made interdisciplinary, HEIs are extricated to the plain of cross disciplinary communication. Having understood what KT means in terms of mechanisms, methods, and measures; how to identify suitable frameworks of implementation such as participatory, entrepreneurial, and industrial; the General and Professional HEIs are ready to go ahead practicing KT research across disciplines.

Conceiving how to expand through what stages, with which components, where, when and how, HEIs with the help of the suitable framework adopted by them for the best use of KT opportunities through efficient communication, fruitful interactions, and

successful partnerships for attaining the postulated goals, grow to success. They adopt both the Participatory Framework as well as Industrial Orientation Framework.

Evidence based iterative production of goods and services is also scalable.

Medical Colleges as institutions bound to train graduates as practitioners can easily engage in KT through systematic observation of empirically given practical evidence. They can undertake iteration of evidence-based practice.



HEIs of engineering and technology progress with translation of theoretical knowledge into useful goods and services in a non-linear course of trials and errors. They gain discoveries and inventions enabling evidence based iterative production of goods and services. Engineering colleges can engage in KT of the linear course as well. Their KT activities are scalable in a phased manner through the startup.

Startups need incubators accelerators for support in the form of funds, expertise, and working ecosystem. HEIs themselves can establish incubators and accelerators.

HEIs should attract both social and industrial collaboration to research, which at once fills the gap between knowledge and its uses. It is important to address the unevenness among users themselves (J.M. Beyer, 1997). Social participation will adapt knowledge to suit the local context and meet people's needs. In the process the innovative dimension will become explicit. HEIs must assume 'entrepreneur' role to identify the potential goods and services from it. Industrial collaboration follows designing products and assessing the feasibility of scaling their production. On experiencing success, industries draw closer to institutions for more collaborative researches yielding evidence of iterative value.

It is necessary for the HEIs to discover the socially or industrially relevant knowledge and its potential adopters. Once this is done, its production has to be planned and executed through the academic wings concerned, ideally in collaboration with the local people or industry. Either way the knowledge would require adaption in terms of concept, types, and levels in order to be serviceable. As a comprehensive framework that begins to incorporate the full cycle of knowledge translation from knowledge creation through implementation, it helps HEIs significantly.

HEIs can successfully implement it by redesigning research into a system of knowledge production for translation. The essential features to be ensured are: 1) Problem driven investigation, 2) Curious researcher, 3) Appropriate institutional environment, 4) Academic freedom, and 5) Necessary physical infrastructure. These five features have equal importance. Outcomes of such researches will be types of

knowledge amenable to translation. Researchers with experience in issue-based research, institutional leadership of persuasive nature, entrepreneurial competency and industrial contacts can make the process easy.

Our HEIs should strengthen their research and innovation sector by nurturing many youngsters of original ideas for boosting KT and setting up several startups. Creating a conducive ecosystem for startups is extremely important. Startups can provide opportunities for students seeking employment under EWYL scheme. Incubators and accelerators play a key role in the promotion of startups. As already discussed earlier, there exist many of them in the Government, the private and the NGO sectors, besides universities themselves supporting startup initiatives. They provide material as well as academic resources and technological services, including the manufacturing and administrative spaces, besides mentoring.

HEIs should choose the right incubation centre and appropriate startup accelerator keeping in mind the incubator ideal in terms of funding and acceleration. It is necessary for them to know how incubators differ from accelerators and what service each render. They should be able to connect with incubators and access avenues of potential partnership opportunities. HEIs experienced in entrepreneurial world of technology and management should institute incubators for helping others.

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Reflections

Prof. Saji Gopinath *(Vice Chancellor Digital University, Kerala) opines that some of the areas need more emphasis, while the Guideline Document addresses most of the issues:*

i) *Prof. Saji Gopinathan thinks that there is an implicit assumption made (perhaps rightly so) that the key issue that limits KT in (from) HEIs is in the knowledge production process. The Issue based approach combined with revamping of scholarship is suggested to address this issue. While he agrees that the knowledge production process in Universities needs substantial improvement, even in cases where quality research happens (as measured by publications in Q1 journals and other leading publications/conferences or reputation of individual/school among the peer), the extent of KT is low. The document suggests development of a Startup ecosystem to address this. While this is a model widely recognised (and examples of CIIE Ahmedabad and SINE Mumbai were quoted), Prof. Saji Gopinathan is not sure, whether it has really resulted in output. Most of the startups from CIIE or SINE or T-Hub (or even TiMED in Sree Chitra) are the ones who comes with their own technologies and use the facilities and expertise in the parent institutions to cu-rate it further. The number of startups which successfully made KT from IIT or IIIT or SCTIMIST to develop the products is not very large.*

So, there are missing dimensions of technology readiness and scalability, which limit the applicability.

ii) *The Document has suggested iterative development (EBIP) as a way to address adaptability and scalability. However, there is an economic cost to this process which is a key deterrent in the translation process. While well established companies with economic prowess could be the right agents to drive this translation, they often prefer time tested plug and play technology while resource poor startups and MSMEs end up with semi-finished knowledge/technology, which needs multiple rounds of iteration before it could develop into scalable applications. This catch 22 situation needs to be broken. Translational Research centres and University incubators are idealised as right instruments to address this issue. However, in reality their achievement in this space, barring a few (primarily due to individual leadership) exceptions, is meagre. Prof. Saji Gopinathan thinks while we plan the agenda for KT, this needs to be looked at in much detail.*

iii) *Much of University research happens in controlled conditions. Due to limitations of tools to manage complexity, research frameworks make limiting assumptions to have problem computationally or experimentally tractable. While this leads to solutions, they are often far from the reality. Relaxing assumptions and delving deep into nuances of real world while letting go of some of academic rigidities of perfection is required to get a workable solution. This is a steep challenge for a researcher and require a completely different mindset and orientation. Such a shift can also be*

detrimental to skills that could create fundamental research too. So there is a need to create mechanisms within HEIs that addresses this. This is especially true in those HEIs who have reasonably robust research process (or those in which at least a few great scholars are there) There is a need to create TECHNOLOGY INCUBATORS which incubate and scale up knowledge rather than users of knowledge (startups)

iv) *Not every knowledge (technology) is scalable easily. Unlike digital technologies most technologies in functional fields require substantial alterations to climb different Technology Readiness Levels. This require HEIs to have resources with such skills, infrastructure and other supporting facilities to drive such transformation. In India HEIs in Agriculture sector has done this well to a great extent But that is because they have developed a strong mechanism of field extension and field level EBIP trials. Indirectly the State had provided the risk capital for this through various subsidies provided to the farming sector. How such a model to be adopted in other sectors could be an area worth exploring.*

Professor Sabu Thomas *(Vice Chancellor, Mahatma Gandhi University) made the following remarks:*

i) *Connections or partnerships between universities and industry are a prior step towards inculcating a culture of translation in the minds of students. Conferences and workshops could be conducted regularly by the HEIs in collaboration with industries which will help the students identify the path to transform their ideas and knowledge into products.*

ii) *The HEIs can issue a policy allowing students to take 6 months or one year off to pursue an entrepreneurial venture. Credit-based entrepreneurship and innovation courses can be made compulsory for all streams of education. Investments and reform efforts can be incorporated into vocational education which should occur at every level of graduation.*

iii) *The adaptation of the Chinese government in introducing Sino-foreign joint ventures between universities has successfully transformed their university students into entrepreneurs. Such systems will push a culture of new thinking and pedagogy into the students, encouraging them to experiment and change. Thus, our HEIs can liaison with the industry helping transfer the technologies. New policies governing faculty interventions can solve the problem of Intellectual Property ownership.*

iv) *The Idea of Design Thinking, developed by institutions like Harvard University, has been adopted by HEIs across the world. In order to educate innovative talents, Design Thinking is the best option, which can be recommended as a core curricular prerequisite for exposing the*

students to real-world problems. Design courses enable students to consider human perspectives throughout the designing process and provide an opening wedge for them to have innovative thinking in problem-solving.

Success stories from MGU

- ***Abtec Nanopower** is an organic product specially designed through nanotechnology. Nanopower perfectly improves plant growth and immunity and helps to fight diseases in all kind of agriculture crops like beans, amaranth, cucumber etc. It helps to fight diseases like leaf spot, leaf blight, stem rot etc. This product causes no health or environmental issues and are safe to use in edible crops as well as ornamental plants.*
- ***Inner liner and inner tubes for automotive tyres** have been developed in collaboration with Apollo tyres. This is under the stage of translation with the company.*

An Autobiographical Illustration

Sri. C. Balagopal *(founder Managing Director of Terumo Penpol Ltd)*

(Sri. C. Balagopal, after serving six years as an IAS officer, decided to quit the service at the age of 30 and start at the bottom of a completely different career as an entrepreneur to implement India's first hi-tech biomedical manufacturing project using indigenous technology developed in a national lab. The know-how to make blood-bag systems that are essential for any national blood service, was developed at the Sree Chitra Tirunal Institute for Medical Sciences & Technology (SCTIMST), an Institute of National Importance created by an Act of Parliament, and functioning under the Dept of Science & Technology, GOI. This was the first technology that was transferred by the SCTIMST which had been set up a few years earlier)

Sri. Balagopal in his autobiographical note, 'The Role of Innovation and Creativity in Managing R&D in SMEs-Learning from the Story of Terumo Penpol Ltd.,' provides a brilliant illustration of KT.

The story of a small startup using every available means to find technological answers, using the resources available in national labs, engineering college labs, and eventually setting up its own R&D lab building a team of competent researchers under the guidance of veteran scientists who had retired after distinguished service is one that hopefully contains lessons that other SME enterprises in India could emulate. 'The venture ran into the expected problems of scaling up an untried technology. After a very difficult initial few years when the venture came near to shutting down several times, the company gradually stabilised operations, and became one of the success stories in the commercialisation of indigenous technology in India. Today, the company is one of the largest makers of blood bag systems of high quality in the world, and its products are used in more than 50 countries on every continent

In this brief note, the focus is on the various ways in which the company overcame its many constraints and handicaps, and used innovative ways of finding technical answers to complex problems.

The purpose of this note is to summarise the ways in which Terumo Penpol Ltd (TPL) sought to overcome severe resource constraints while seeking answers to the difficult technological questions, using innovative ways of using any resource that is available. The note covers 5 themes, each dealing with a key aspect of the way the company responded:

1. *The first has to do with the way the company worked closely with the SCTIMST;*
2. *The second is about the way the company developed relations with other labs and institutions for the same purpose;*
3. *The third is about the reasons that compelled the company to set up a full ser-vice R&D centre despite being in a precarious financial position;*
4. *fourth, the need to promote collaboration between the R&D Dept. and the shop floor where problems are encountered; and*
5. *The fifth, the readiness of the top management from an early stage of its journey, in allocating adequate finances for R&D despite a difficult financial situation.*

Collaboration with SCTIMST

The realisation that a close working relationship with the SCTIMST was crucial for the company's survival dawned at a very early stage, and in fact influenced the decision to shift the site of the project from one that had already been acquired for the purpose near Hyderabad to one near Trivandrum, barely 10 km from SCTIMST. This enabled our engineers to drive to SCTIMST and discuss a problem and return to the factory and try out a solution that was suggested! The relationship with SCTIMST was built on the sagacity and wisdom of our first Chairman Prof S Ramaseshan, former Director IISc and then Chairman, Technology Development Committee of SCTIMST. On the suggestion of a friend, I met Prof Ramaseshan at his spacious offices at the Raman Research Institute where he was Emeritus Professor, and put forward my request which he readily accepted.

On the advice of Prof. Ramaseshan and Dr. M.S. Valiathan, Director SCTIMST, I invited Prof A.V. Ramani, Head Bio Medical Technology Wing, SCTIMST on the Board of Directors of the company. Thanks to their joint efforts and initiative, I was also able to get a senior experienced engineer from SCTIMST to be the Project Engineer during the first crucial year while the factory was under construction. All these together ensured smooth flow of personnel and ideas between the SCTIMST labs and the factory.

Key Learning: *SMEs must develop close ties with one key HEI that is a leader in the domain in which the SME works.*

Collaboration with Other Labs and Institutes

There were situations when testing required resources that the SCTIMST did not have, or the problems were not of such an urgent nature requiring the inputs of the SCTIMST. Thanks to the guidance of Prof Ramaseshan, we were able to access the facilities of the Sophisticated Instruments Facility (SIF) of IISc to get important tests done. We were also able to use the facilities at RRL - Trivandrum, SITRA – Coimbatore, FACT – Kalamassery, CFTRI – Mysuru, and other facilities as the need arose. This awareness of the resources available in institutions around the country, and the readiness to approach them to request them for their help, became a part of the way technical subjects were tackled at TPL.

The company encouraged engineering students to do their summer internships and term papers with our company, and gave them parts of problems we were working on as subjects for their work. This enabled us to get the inputs of highly motivated students who wanted to do a good job and were fully engaged by the

fact they were working on real problems, with the guidance and supervision of their professors. This was done with College of Engineering Trivandrum, TKM Engineering College – Kollam, and other HEIs.

***Key Learning:** SMEs must establish close links with HEIs in their vicinity as that will enable them to carry out testing and studies that will otherwise not be possible with their limited resources.*

Setting Up In-house R&D Dept

Despite the collaborative approach adopted with SCTIMST as well as with other HEIs, it soon became clear that the company would not be able to complete important tests and investigations to tight time frames if we had to depend all the time on the resources and facilities in other institutions. We, therefore, went about the task of setting up a full-fledged R&D Centre initially in the field of Plastics Processing & Technology, where new materials in new combinations could be developed to yield the properties, we were interested in. This was set up under the leadership of Dr. C.S.B. Nair, a distinguished scientist who had retired from the Central Fuel Research Lab at Dhanbad. Another brilliant young scientist Dr. A.S. Padmanabhan, who had just been awarded a PhD in Polymer Chemistry at Drexel University, USA joined this team, and a couple of other young scientists also joined.

We soon realised that the crucial biological evaluation of every new material or combination of materials used could not be done to tight time lines if we had to depend on external resources. The decision to set up a Biological R&D Lab was taken, and the resources for that were found with much difficulty. This lab was

headed by Dr. P.A. Kurup, who had recently retired as Head, Dept of Biochemistry, University of Kerala, a brilliant scientist and a pioneer in the field in the country. He soon built a competent team of scientists who were able to undertake the full range of teats and evaluations we needed.

***Key Learning:** Each SME must invest in a small R&D Center, that will focus and document the development efforts that go on all the time on the shop floor.*

Need to Embed R&D in the DNA of the Shop-floor

While the company strove to consult the best scientific talent available to help us answer difficult technical questions, it was important for the entire team to be imbued with the spirit of scientific enquiry and seeking answers. The 'trial and error'(T&E) method is what works best, as every technical question cannot be always answered fully or even satisfactorily in terms of existing scientific knowledge. There must be a willingness to take risks, and try something entirely new, something that may even be counter intuitive. Often, it was such a 'shot in the dark' that yielded the breakthrough. R&D must therefore be seen as a company of wide activity, indeed an approach to the way things are done, and not as something that happens in the 'R&D' Dept.

We learnt early that much knowledge creation happens on the shop-floor, as a result of T&E, and it is only later that we find the reason why something works, and how it works. The close collaboration between the R&D Dept. and the Production Dept. is a necessary condition for T&E and innovation to become part of the DNA of the enterprise.

Key Learning: Knowledge creation happens mostly on the shop-floor, as a joint effort of the R&D Team and the Production Team, and a collaborative style of working must be fostered. SILO working must be actively discouraged, as it will kill innovation, and end up in finger pointing and the blame game.

Management Support in Funding R&D

While hiring skilled scientists and technologists is a necessary condition for productive scientific efforts, it is important to see that they are provided with the wherewithal to do their work. This is an area where there is unfortunately a huge gap between promise and delivery. Eventually this ends up with scientific personnel becoming frustrated and leaving. It is important, therefore, for there to be top management commitment to providing sufficient capital expenditure budgets for acquiring the equipment needed, and funds for the consumables and other related expenses to enable the work to go ahead unimpeded.

Managements find it difficult to understand the unpredictable nature of such problem-solving R&D and innovation projects, and demand plans and forecasts that are difficult to provide. This becomes an area of friction and misunderstanding. In our case, the problem was overcome because the CEO was convinced of the overriding importance of R&D and hence was committed to ensuring adequate resources were provided, even when the company was passing through very difficult times.

***Key Learning**: Top management commitment to ensuring adequate funding for R&D projects."*

Source Material: *The source material for this story of technology transfer from lab to factory is to be found in several documents that form the official record at SCTIMST, the company records of TPL, the recently published book by Dr C S B Nair (who headed the R&D efforts at TPL) titled 'Indigenous Technology: Development, Transfer and Commercialisation – the fascinating story of the development of technology for the manufacture of blood bags in India', and finally the articles and talks by the author of this note at various seminars and workshops over many years.*

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