Improving technology commercialization at research institutes: Practical insights from NCL Innovations*

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Abstract:

NCL has a strong history of technology development and transfer. In recent years, NCL has been exploring and experimenting with new models to increase technology productivity and take technology to the market including business incubation and public-private partnership models – an activity being driven by NCL Innovations, a resource center of NCL. This experience has provided the NCL Innovations team insights into the challenges in commercializing technology in the Indian context. We outline in this paper some key challenges that publicly funded research and technology development organizations in India face in translating scientific capabilities into products and services. We also discuss initiatives of NCL Innovations and Venture Center in trying to overcome or work around these challenges. We conclude by highlighting the need for a multipronged approach to increasing technology productivity from publicly funded organizations with strategies that are deeply rooted in practical issues facing researchers.

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+NCL Innovations (www.nclinnovations.org): NCL Innovations is a resource center of NCL that supports, promotes and champions the cause of technology innovations within NCL.

++Venture Center (www.venturecenter.co.in): Venture Center strives to nucleate and nurture technology and knowledge-based enterprises by leveraging the scientific and engineering competencies of the institutions in the "Pune region" in India. The Venture Center is a technology business incubator specializing in technology startups offering products and services exploiting scientific expertise in the areas of materials, chemicals and biological sciences & engineering.

Introduction

In India, there is an urgent need to put in place systems and measures for efficient transfer of technology from the laboratory to the market and commercialize the technology. This would be the first step in harnessing the technology developed in our laboratories to be put to use for the benefit of the larger economy. Businesses, by offering products and services based on technological innovations, can gain a long-term competitive edge. And, technology could provide the key to solve wide-ranging grass-root problems in India.

Research initiatives from within industrial organizations have a much sharper focus on commercialization, and in most cases research is driven by needs in the market. Also, when the commercial arm is co-located within the organization, there are built-in mechanisms to translate the research to the market. But the reality is, in India, the majority of the R&D spending happens outside the industrial sector. In 2005-06, the Industrial sector (which includes both public and private sector organizations) contributed about 30% of the total R&D expenditure in India[i]. The rest of the R&D expenditure was borne by the various central and state government agencies. In such a scenario, where the majority of the country's R&D activities are done by public research organizations, which are removed from the commercial arms of the economy, the need to translate that research into commercial products and services becomes imperative. And the need to have mechanisms, policies and people who will facilitate effective technology commercialization cannot be overlooked.

NCL Innovations is one such initiative – a resource center in the National Chemical Laboratory (NCL) that supports, promotes and champions the cause of technology innovation within NCL. NCL is one the flagship laboratories of the CSIR with around 200 researchers, 500 students pursuing their PhDs, and over 800 project assistants, working on various aspects of chemistry, chemical engineering and biotechnology.

NCL has a rich track record of working with the industry and developing technology and commercializing it both within India and abroad. In its 60 years of existence, NCL has hand-held and developed basic technology for various industries in India. In the 1950s, NCL was instrumental in setting-up some of the first organic chemicals and dyes manufacturing industries in India. Later on, during the Green Revolution (1960s), NCL made significant technological contributions in setting up many agro-chemicals based industries. In the 1970s, when the process-based patent regime was ushered in, NCL worked with various pharma companies and developed processes for manufacturing several drugs (the first set of drug molecules commercialized by Cipla in the late 1970s was based on NCL-developed process). In the 1980s, NCL focused its efforts towards developing technologies aimed at taking India towards technological self-reliance. In the 1990s, NCL worked with a string of companies (including several MNCs, many of them Fortune 20 companies) and marking up significant successes in commercializing various industrial processes and technologies.

In most of the commercialization efforts listed above, NCL has worked with industries and commercialization partners by licensing NCL's technology for a fee (or royalty or a combination of upfront fees and royalty). This model of technology commercializaton, while having worked in the past, is great for many technologies but is not the ideal model for all technologies developed at NCL. Some technologies, while not having any direct applications right-away, may have significant potential after some development work. Some other research results might need a few years of development and fine-tuning before they become attractive technology licensing options for industrial partners. There is a need for commercialization models that can accommodate some of these needs as well, and take these technologies to the market.

For the last few years, NCL has been looking at alternate models (other than straight licensing of technology to partners) like creating start-ups based on its technology or entering into public-private/public-public partnerships to jointly develop and commercialize its technology. NCL Innovations was set-up in 2007 to explore and operationalize these alternate models of technology commercialization along with previously existing models. For these alternate models to work, it is imperative to have an eco-system in place that supports these initiatives. An eco-system which one could access to seed-fund the startup created. An eco-system which one could tap to identify the entrepreneurial team, to lead the startup created. An eco-system that brings in technologists, market experts, financiers, and entrepreneurs who would work together in setting up and running the startup companies and public-private partnerships.

There are very specific challenges we, at NCL Innovations, face in operationalizing these alternative models of technology commercialization, and creating the necessary eco-system around NCL. In the next section, we discuss some of these challenges, and in the one following that, we discuss some of the successes we have had, and the future course of action.

Challenges in Innovation and translating laboratory science to the market

Mindset of Researchers

One of the main challenges research institutes face in translating laboratory science to products and services is changing the mindsets of the researchers and scientists. Most scientists in India (or for that matter in most parts of the world) value blue-sky research over application-oriented research, value publishing in a respected journal to patenting and commercializing their research. Many believe that "doing business" (meaning starting companies) is something beneath their value system and not worth their time. Part of the reason for this behavior is how the scientific establishments traditionally function. Another reason is how scientists are incentivized. In research institutions in India, scientists are evaluated based on the number of journal papers they publish, number of PhD students they supervise and graduate, amount of external funding they bring in etc. Their technology-based achievements are seldom recognized. Under these conditions, it is difficult to convince a scientist to dedicate his/her time to a risky technology-based project that would take large chunks of their time and might or might not lead to commercialization (one cannot ignore the technology risks involved in such

projects, and hence, by definition, higher rates of failure). Given the incentive structure, the scientist would rather work towards producing quickly publishable results and graduating PhD students.

In addition to this, the lack of transparent intra-institutional policies on protection of intellectual property, technology transfer and commercialization do not encourage filing of patents and hinder commercialization efforts. Many scientists are not even aware of the process and the merits/demerits of patenting, and in many cases, they publish their results without filing a patent application, and unknowingly end up sabotaging the possibility of protecting their technology through patents (by publishing first and filing later, in many countries, the scientists' own work is cited as prior art by patent offices for refusing to grant patents).

Policies and implementation

When it comes to exploring new venues for commercialization, until recently, there wasn't any national level policy that allowed scientists to start companies and institutions to hold equity in those startups. (In May 2009, DSIR, Department of Scientific and Industrial Research issued a notification[ii], which allows scientists working in many government funded research institutes to promote technology startups and for research institutions to hold equity in startups.) The notification by the government is the right first step. But more needs to be done. Clarity as to how to operationalize these options is needed. And scientists and institutions should be encouraged to utilize these options. Clear-cut guidelines regarding creating startups, public-private partnerships etc., need to be developed. The existing rules are policy document driven, and in most cases, shaped and interpreted by the opinions and priorities of the respective leadership of these agencies. Other initiatives to allow mobility of scientists working in govt. R&D labs and industry have also been underway[iii].

Disconnect from problems, removed from the markets

Researchers, by means of not being in close contact with the markets and the industry, do not choose to work on problems plaguing the market. Problems which when solved can add value do not come to the notice of the scientists working in research institutions. Lack of strong links to the industry, and lack of a common platform (conferences, meetings etc.) to interact with the industry folks are reasons for this. Conducting research removed from the market also leads to a weak knowhow/IP pipeline in research organizations.

Research Projects vs. Technology Projects

Research institutes have strong research competencies in various areas, many of which have great commercial potential. But much needs to be done before they could lead to commercial products and services. First, a market need (or problem) has to be identified and a "proof-of-concept" project needs to be undertaken, in which a technology solution is developed and tested. And further work needs to be done to evaluate and see if this technology solution can be delivered in a cost effective and commercially sustainable way. These projects (let's call

them “technology projects”) are a different ball game when compared to the research projects, which scientists usually undertake.

Research projects are done in homogeneous groups (where everyone involved is trained in science or engineering) headed by the project leaders. The nature of the problems is well defined and there is a definitive answer to many of these problems. The scientific rules governing the problems are well defined and there is very little uncertainty there. However, technology projects typically involve people with expertise in various domains. Technologists have to work with people who understand the market better (management or marketing folks), along with product development specialists and entrepreneurs who will work closely in shaping the project by reminding the team of the constraints of the market, the product specifications, price, etc. There is a lot of uncertainty in these projects. Various other factors, other than scientific rules and goals, may determine the success of the project. For researchers to run such projects is not an easy task. They are not used to working in such uncertain, multi-disciplinary projects. Such projects need to be headed by innovation/technology managers who clearly understand the scientific/technological and the commercial needs of the project and make decisions accordingly.

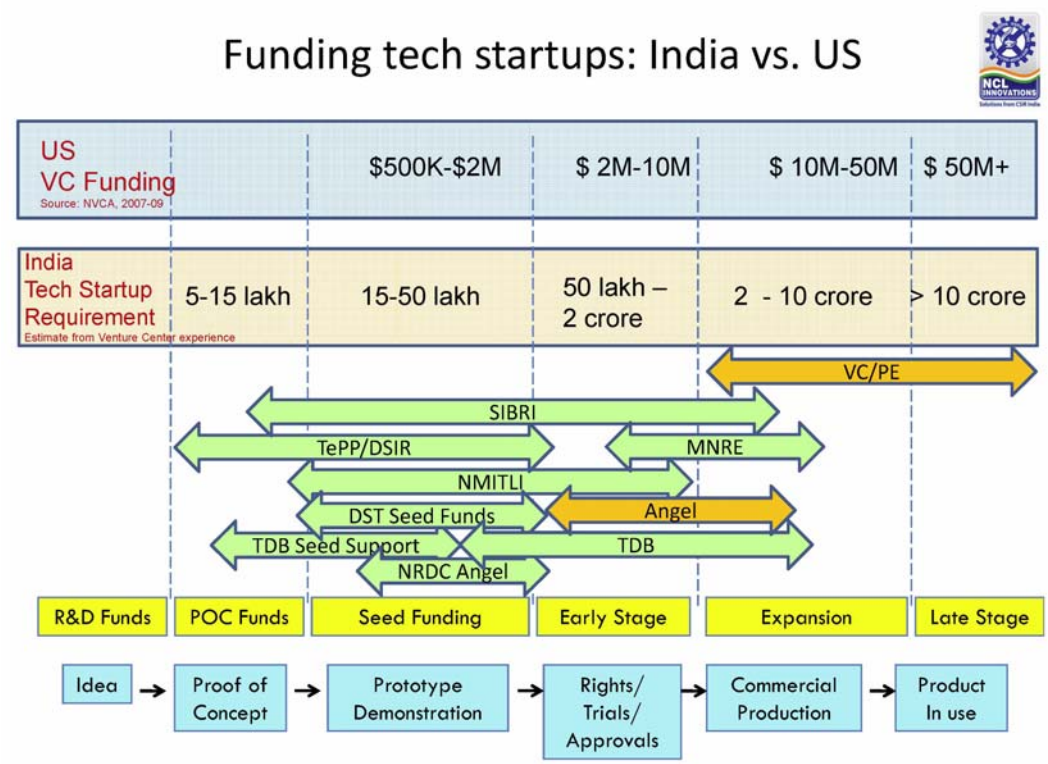
Finding the right people

Finding and retaining such technology/innovation managers is not a trivial task. Innovation managers who have the right orientation, possess the problem-solution focused approach, who could facilitate the commercialization process in research institutions, and also at the same time create a cadre of people who could take such roles in the future and in other organizations are hard to find and retain. It is difficult to identify the entrepreneurs or industrial partners who will partner in such efforts, and work with you through the tedious process of de-risking the technology before it becomes market-ready. Also, once the technology startup is ready to be formed, it would need an entrepreneurial team, people who can take and manage technology risk, which can dedicatedly lead the effort and built the company up. Once again, finding quality people for this entrepreneurial team is not easy.

Finding the money

Finding the resources to conduct these technology projects, and once the projects are successful, if you decide to float a startup, finding seed funding for these technology startups is the next big challenge. Technology startups (excluding IT-focused technology companies) have a longer gestation period and need lot more resources to cross the early stages of development, because, by definition, technology companies would consume lot more resources (like special equipment, lab facilities, trained manpower to run these projects etc.) to de-risk their technology and to launch a product or service in the market. Which also means that it will take longer to recoup the investment and turn profitable. This needs investors who are both patient and can work with the special needs posed by technology startups. Particularly, there is a big gap in funding for tech startups under Rs. 2 to 10 Crore. There is a need for making available flexible grants (from the government or other sources) below Rs. 2 crore, and make these sources quick to access.

Figure 1: An overview of the funding landscape for tech startups: India vs. US. In India, there is a gap in funding for early stage tech startups that is currently being filled by government schemes.



Clarity, transparency, awareness

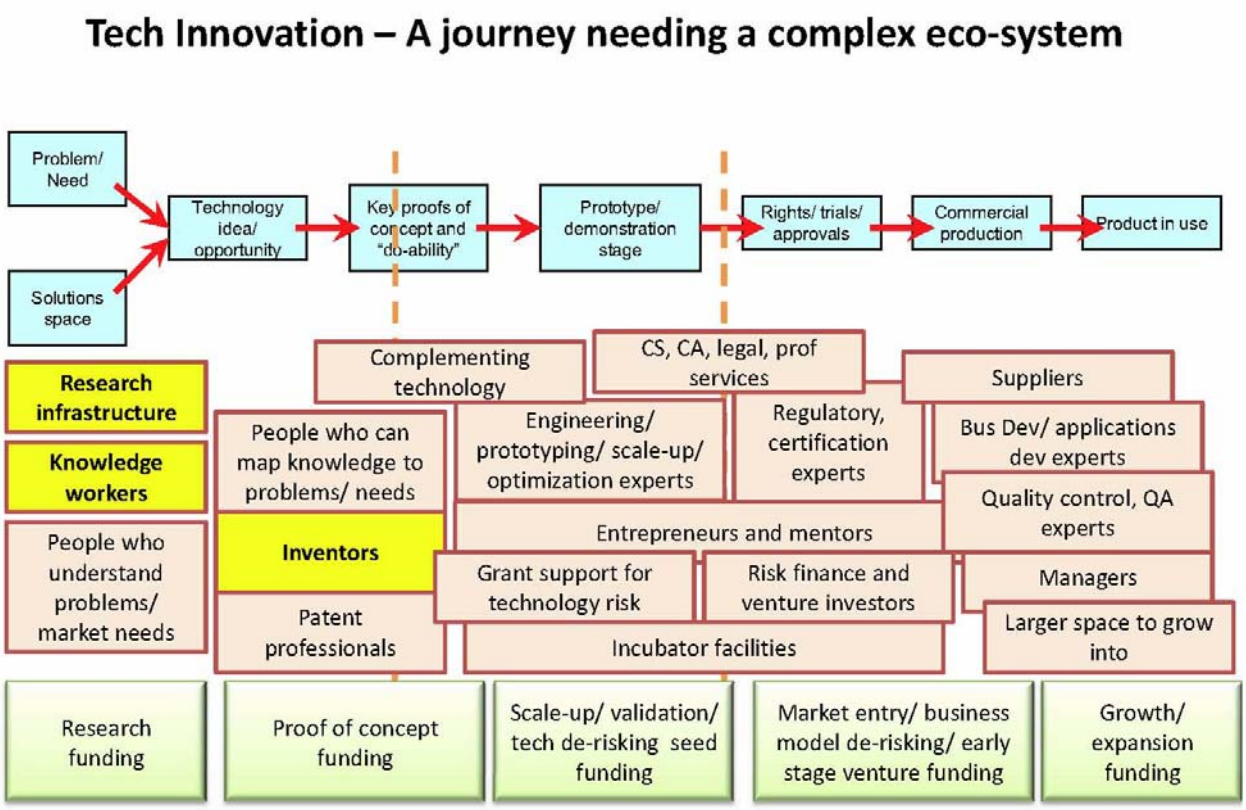
As can be seen from the issues discussed above, there are various partners (entrepreneurs, market experts, investors, industry partners, technologists etc.) that the research institutes need to work with to commercialize technology. All of these players come from various backgrounds and have their own priorities. Their terms of engagement with the research institute and with each other need to be very clear. The policies governing the IP rights, commercial rights, equity holding pattern, etc. need to be as transparent as possible right upfront. Clarity, transparency and mutual awareness about expectations, policies and constraints will go a long way in smoothening the tech transfer process. Trained technology transfer professionals are needed in research institutes to fulfill these needs. These folks need to be trained in science/engineering and have experience in either business or law to best execute their roles.

Indian companies and aversion to technology risk

Most Indian companies are averse to taking on technology risk. First, they have other sources to deploy their capital and earn reasonable rates of return. And there is still plenty of opportunity to earn similar if not higher returns by venturing into non-technology-based sectors like retail, banking, infrastructure, entertainment etc. When companies have other

venues like this to deploy their capital, they hesitate to deploy it in high-risk technology-based projects, which have a longer gestation period before they yield any returns.

Figure 2: Various components of a complex eco-system that is needed to take technology innovations from the lab to the market.



Need for an eco-system promoting tech innovations

There is a huge gap in the demand and supply of professionals to support the technology commercialization process. There is a big need/demand for professionals like IP lawyers, legal service providers in tech transfer, business plan writing, advisors in company formation, and other allied services. Also, there is a need for strong networks to be formed and nurtured between and within entrepreneurs, technologists, investors, researchers, tech transfer professionals etc. Another main component of the ecosystem that needs to be developed and strengthened is technology business incubators that support tech startups by providing physical space, facilitating funding, and offering other advisory, professional services.

Responding to the Innovation Agenda: Initiatives by NCL Innovations

Mindset changes – lectures, workshops, and outreach

The best way to get a scientist's attention and convince him/her about the merits of pursuing technology projects is through other scientists - other scientists who are widely respected in their fields; even better would be scientists who have significant academic accomplishments and at the same time turned entrepreneurs or successful technologists. Having these scientists-turned-technology-entrepreneurs visit and talk and interact with researchers about their perspective and how they commercialized their research is a great way to initiate the change in the mindsets of researchers. We have had many such scientists visit us, and spend a day or two interacting with our scientists[iv]. Other speakers have been invited to talk on new models, institutional mechanisms, and other issues in tech transfer and commercialization[v]. Also, we have held in every scientific division at NCL, an introductory talk on patents and how scientists can use it protect their ideas – these talks are very informal and peppered with subject-specific case studies on the patenting process, followed by discussions. Also, through our website (nclinvoations.org), we showcase our technologists and inventors, and their achievements, awards, recognitions – through which we hope to highlight and recognize their contributions to the larger scientific community.

Apart from targeting the scientists, we also look at the larger scientific community at and around NCL, and offer very focused courses and workshops (of 10-12 week duration) on topics like "Patenting for Researchers[vi]", "Business Plan Workshops for Students[vii]". These workshops apart from educating students and researchers on these issues, we hope will serve as a ground to attract the right people for future technology related projects. We also support and facilitate an active student group, NCL-Technology Entrepreneurship Club (NCL-TEC)[viii], which brings together students who are interested in technology, entrepreneurship and runs events, workshops, industry visits etc.

Putting Institutional mechanisms in place for scientists

We have created many of the institutional level mechanisms to operationalize the national level policies on scientists starting technology ventures, and research institutions holding equity in startups etc. We have prepared the ground work for many of these schemes to be implemented and created the process for doing so.

With respect to the IP management, we have streamlined the process and all forms and other process related documents are hosted on our internal website. Apart from protecting the ideas and technology after it has been developed, we have used to analytics to intervene and assist our researchers event at the stage of project planning. For example, before initiating a research project, we perform "landscape analysis" studies, which summarize how others have approached a given problem and gives information on whether the current approach proposed by our scientist is a novel one. Such early interventions help scientists to focus their efforts, and structure their projects accordingly.

Many of these efforts have started yielding encouraging results. One of the measures of research productivity as in the number of commercializable technologies developed is the number of invention disclosures we get in a given year, for the research expenditure incurred[ix]. Let us, for this discussion, consider the technology transfer offices in U.S. Universities as our benchmark, and the number of invention disclosures they get (for every dollar incurred in research expenditure) as a measure of research productivity. Over the last 10 years, on an average, the U.S. Universities have produced one invention disclosure for every $2.5 million incurred in research expenditure. Considering the budget of NCL in 2010 (Rs 120 Crore), and adjusting it with the PPP rate[x], one can expect NCL to produce around 32 invention disclosures per year. Actually, NCL produced 39 invention disclosures in 2010, far exceeding the benchmark of the U.S. Universities.

Seeding research ideas- Idea catalyst workshop series

Apart from facilitating the process of taking existing technology to the market, we also actively work towards seeding ideas for new technology products and services. One such effort is the NCLI IDEA Catalyst Workshop Series[xi], under which, we bring in market experts and practitioners who have rich experience in their respective fields, to come and talk to our scientists about existing problems in their areas, and technology opportunities that our scientists can work on and create a solution. Apart from this, we also look at focused markets and identify opportunities in that market. For example, recently we looked at the technology business opportunities and research opportunities for scientists in the water market[xii].

Transparency, policies, awareness of partners

We have also created a platform to interact and communicate with our technology partners: www.nclinnovations.org. This website lists many of the policies and models that we are open to exploring in tech transfer and commercialization projects with partners. We have also used this site to showcase our commercialized technologies and also the available knowhow at NCL. By way of this effort, we hope to promote transparency of our tech transfer policies and procedures. This effort is still evolving, and a lot more needs to be done on this front.

Building Innovation Management Cadre

We see training prospective innovation managers, scientist-innovators, and entrepreneurs to work with technology ideas and take technology risks is an integral part of eco-system building. We have run focused workshops for various such target groups on accelerating technology commercialization (ACTIV)[xiii], and nanotechnology commercialization[xiv] etc. Also, we run other such events and programs that serve as forums to bring together students, scientists and entrepreneurs. We have also created a dedicated library, which is open to the public, for entrepreneurs, technology managers and innovators[xv].

Building the eco-system: creation of Venture Center – a technology business incubator

When looking to create alternate models of technology commercialization, it became apparent that such an effort should involve building an eco-system around NCL that supports and

nurtures such efforts. An eco-system should involve intangibles like networks etc., but also have physical facilities that could support new technology efforts. Venture Center, a technology business incubator, located adjacent to the NCL main campus, was created to support technology based businesses both from within and outside NCL. Venture Center offers ready-to-use lab and office facilities, a library for entrepreneurs and tech managers, various advisory services and facilitates many funding schemes for tech startups. Apart from supporting existing tech startups, Venture Center also actively works towards nucleating many of the So far, over 22 tech startups have been supported and incubated (2 of which are based on NCL/CSIR knowhow), many of which have expanded their operations and graduated from the incubator.

Venture Center also serves as a mode to interact with entrepreneurs in and around Pune. Venture Center has become the nucleus for many of the technology/entrepreneur networks in Pune, and all these networks are quite valuable and could be tapped in the future for commercializing technology.

Defining, running technology projects and funding them

Running technology or "proof-of-concept[xvi]" projects involves assembling the right set of people who can do market research, find out specifications of current products in the market, and figure out if a particular technology could result in a product or a service that could be cost effectively and sustainably commercialized. And reduce these inputs into specific scientific goals and work with the researcher/technologist to do testing, experiments, product development etc. for a given technology. And finding funding sources for these projects is also critical. Venture Center's Lab2Mkt program outlines a systematic way to execute such projects[xvii]. The recently announced CSIR-Tech[xviii], will deploy this Lab2Mkt framework in an aggressive way to commercialize technology from CSIR labs.

There are various initiatives underway to address the specific funding requirements to run such technology projects and create tech startups. First, NCL has created dedicated pockets of funds that are specifically meant for running early stage technology projects, which will test possible tech ideas for a problem and the end-result will be a product or service that can be commercialized (and not a journal publication). This funding, while sufficient to work with resources and people from within NCL, has limitations on how flexibly it can be deployed. Venture Center has recently received a grant from DST, Govt. of India, to run "Proof-of-Concept" projects, through which many of NCL's technologies are being tested and refined to see if they could result in a product or service around which a tech startup could be built. These funding sources can be deployed with a little bit more flexibility in running the technology projects.

Apart from this, we have created a funding database for technology startups in India, which lists over 47 different sources of funding (mostly from various government agencies) that technology entrepreneurs can use to fund their startups. This database is hosted on a public site[xix] and is one of our most visited websites.

Figure 3: A Snapshot of the coverpage of Nov 2009 DARE, India's leading magazine for entrepreneurs. An article based on the funding database created by Venture Center listing the various funding options for technology entrepreneurs in India, particularly the government sources, was featured as the cover story.

Funding Database listing various funding sources for technology startups in India: **http://www.venturecenter.co.in/funding**

Conclusions/ Future actions

Improving innovation productivity from research institutions in India needs a multi-pronged approach rooted in practical issues in taking technology to the market. Some of the suggestions we forward here are solutions derived from a practice-based approach that we follow at NCL Innovations.

Some of the largest problems in commercializing technology in research institutions in India today are: (i) weak pipeline of knowhow/IP (ii) weak eco-system for early-stage ideas Suggestions for national initiatives: Create pockets of "bureaucracy-free", flexible grant funding for proof-of-concept projects. Invest in creating a cadre of high-quality technology managers who create facilitating mechanisms and help define problems, and also work toward creating the eco-system conducive for commercialization activities. Invest in hands-on training (as opposed to academic training) of these managers through internships with experienced managers. Minimize bureaucracy in funding, reduce encumbrances on IP and empower R&D institutes and "technologists" to commercialize the technology, as they are in the best position to work towards commercialization of innovations.

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