MEETING REPORT

Bridging innovations in academic institutions to society*

India is in great need of advanced and affordable solutions in a number of areas. The list is endless, ranging from primary necessities such as water, food, energy and health to environmental monitoring and national security. In many of them, there are intense efforts across the country. While unified efforts across institutions are limited, there are several well-thought-out programmes in several areas and there have been important outcomes. These research results and technological outcomes in some cases have not been translated to products that would have benefited the needy. As a consequence, these outcomes have not yielded economic returns and contributed to social development, although investments have been reasonable. A case study in this context is that of water, where we have made sizable contributions in research and technology development. Yet, problems related to arsenic, fluoride, pesticide, etc. continue to persist and our people are left to face the consequences.

Obviously, there is an urgent need to devise mechanisms by which technological outcomes are translated to products in large numbers. New ways of promoting participation of academic institutions in manufacturing processes have to be thought about. Institutions at the grassroots, which ultimately implement solutions and understand end-user requirements, have to be made aware of the technological developments happening in the universities and new bridges have to be built between the two. There is a need to frame policies to enable this handshaking. In this context a discussion meeting was held on the theme 'Bridging innovations in academic institutions to society'. The plan was to invite innovators, scientists and technologists from academic institutions, businessmen from incubated companies housed in these institutions, administrators of various governmental bodies as well as management and policy experts (see Box 1) to share their experiences so as to arrive at definite recommendations to bring research results closer to societal benefits. The recommendations arising from the meeting are highlighted in the following.

The participants debated on these issues in three separate sessions on the first day. The first session was by academicians who have incubated companies and translated technologies from laboratories to industrial setting. These technologies range from national security, biochemical monitoring, advanced medical diagnostics, automotive parts, drinking water purification and such other areas. National laboratories, research establishments, IISc, IITs, JNCASR as well as autonomous centres were represented. Innovation ecosystems in these institutions and structures which facilitate such technology transfer and mechanisms to enhance the capabilities of these institutions were the points of discussion.

The second group of individuals involved in the discussion meeting were from the incubated companies, beneficiaries of technologies derived from academic institutions. Their struggle in transitioning technologies to the market, liaising with government agencies, hurdles in developing a marketable product, acquiring the initial purchase order, manufacturing difficulties in research establishments, obtaining funding into pre-revenue companies, etc. were discussed.

The third group comprised of administrators, non-governmental organizations, individual experts and health professionals. Participants in this group debated on the need to create administrative mechanisms to facilitate technology transfer. For health professionals, the complete lack of link between academic research and medical science being practised in India was a point of concern. For administrators, constraints of rules and regulations in nurturing research and development (R&D) results in sectors of socio-economic benefits, especially in the rural sector, were important points for discussion. Independent experts dealt with a number of limitations of our administrative machinery, which prevented translation of technologies to innovation.

On the second day, individual subgroups discussed specific recommendations for the expected objectives. These discussions were presented to the whole group and consolidated recommendations

Box 1.

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*A report on the two-day discussion meeting, 'Bridging innovations in academic institutions to society' organized by the Thematic Unit of Excellence in Nanotechnology for Clean Water at the Indian Institute of Technology, Madras, Chennai and National Institute of Advanced Studies (NIAS), Bengaluru and held at NIAS on 28 and 29 April 2015.

were drawn. Exchanges through electronic media were used to finalize these recommendations.

The recommendations are grouped together under the broad headings – sharing, caring and direction. Specific actionable points are suggested under each category. Each of the recommendations is elaborated in a few sentences.

Sharing

This captures inter-institutional/inter-disciplinary links to nurture innovation.

- Interactive website – A window for problems and solutions

An interactive website has to be created where available technologies, patents, affordable solutions in various sectors, appropriate contacts where technologies are available, mechanisms of technology developments, possible funding, etc. are showcased. This website has to be periodically updated and constantly interfaced with institutions – academic or otherwise. This must be a storehouse of information for academicians and general public alike. For the former, it provides links as to where one can approach to get quick responses on each of the problems mentioned. For the latter, the information must be on specific solutions for the problems faced by the citizen.

Action: Create an interactive website, housed as part of DST's efforts to promoting innovation.

- Innovation in entrepreneur education

Short-term courses, continuing education-based programmes, local workshops, etc. targeted at nurturing innovation ecosystem must be conducted in R&D institutions. Compulsory training programmes of this kind must be done each year in institutions of higher education and research, especially for new recruits (faculty and research students). An online modular course accessible across the country may be considered.

Action: Continuing education for nurturing innovation to be initiated in all institutions of higher learning; DST may take the lead.

- Common centres for prototyping

Creation of set-ups like Industrial Technology Research Institute (ITRI), Taiwan (https://www.itri.org.tw/eng/) across the country is a necessity. These centres are to be operated and maintained such that they have a mandate to translate technologies to market, if an innovator or interested party approaches them. One model to consider is 'government-owned and contractor-operated' style. The facilities must be available round the clock, throughout the year and can be e-booked by an interested user. Barriers for designing and prototyping in any sector must disappear.

Action: Create ITRI-like institutions; DST to consider the plan.

- National nanofabrication facility for small-scale manufacture

Our engineers and technologists have made their mark in the world working in companies like Intel, IBM and TSMC. IITs and other research institutes are at the forefront in developing novel nanodevices. Several start-ups have been incubated in the country which have either developed prototypes of nanosensors or have at least established a laboratory proof-of-concept. Two such examples are shown in Figures 1 and 2. Figure 1 shows a prototype of arsenic purifier developed by an IIT Madras incubated company and Figure 2 represents a sensor which can detect explosive, developed at IIT Bombay. However, when it comes to manufacturing these devices, not even a single nanofabrication facility that makes them exists. While there are a few at places like Semi-Conductor Laboratory (SCL), Chandigarh, they are not open to private sector and start-up companies. So although a device may have been designed and developed in India, it will be manufactured abroad.

Another aspect lacking clarity in India is the understanding of what happens to the intellectual property (IP) when a start-up company develops a novel device and gets it manufactured at a contract nano-fabricator. It should be noted that such rules are well-established abroad in the semiconductor nanofabrication contract manufacturing industry.

Action: (a) Existing nanofabrication facilities to be offered to the private/start-up sector for contract-manufacturing of their nanodevices while creating such centres exclusively for contract manufacturing. (b) Rules according to international practices be established and adopted regarding ownership of IP in such situations.

- Technology–social science interface

Currently, technologists and scientists do not interact with social scientists. These barriers have to disappear for innovations to take root in institutions. Science–social science network and interactions have to take place in all institutions of higher learning. Specific funds have to be allocated to enable such interactions.

Action: Introduce joint Master's and Ph D level programmes between these departments in reputed institutions; Ministry of Human Resource Development (MHRD), Government of India (GoI) to initiate a discussion.

Figure 1. Scene from a school in Nadia district, West Bengal. Children are drinking water from a filter which removes iron and arsenic selectively, attached to a hand pump. The technology was developed by IIT Madras and was commercialized by an IIT Madras incubated company with the support of the district administration and the Government of West Bengal.

Caring

• Technical commercialization funds for social innovation

Government mechanisms for supporting new technology commercialization, especially for rural India, are critical. Government has permitted the use of corporate social responsibility (CSR) funds for investment in approved technology incubators. Technology incubators are now present in almost all the major cities in India. Entrepreneurs aiming to take technologies from laboratory to rural India can be located at these incubators while being close to their application market. 'Centres of Social Innovation' may be set-up in select incubators.

Action: The Ministry of Corporate Affairs, GoI can generate policy guidelines on the use of CSR funds for technology commercialization in rural India. A list of approved incubators may be added to the guidelines. The Ministry can also organize an annual rural technology mela (demonstration platform for entrepreneurs), to show how CSR funds given to incubators is helping to improve rural India.

• Incorporation of sustainability principles in products and practices

National curriculum at the school must include principles of sustainability. New products that are being developed in Indian laboratories must consider these principles and for that the current school-going generation has to be sensitized. Sustainable growth realizes that resources are basically of two kinds: (1) those which can be replenished and (2) those which cannot be replenished. If resources used in making products can be replenished, the following are to be strictly followed: (1) the rate of consumption is not greater than the rate of replenishment; (2) the end-product is non-toxic, and (3) it is bio-degradable. If the resources used cannot be replenished, it is essential that all of the material used is recycled. However, it is not easy to make this change and in the present scenario, it may be impossible in several products. However, a beginning can be made by training students in the fundamental aspects of sustainability.

Action: MHRD to take note of the principles and recommend their incorporation in NCERT textbooks and national curriculum.

• Biotechnology Industry Research Assistance Council (BIRAC) – type models in all sectors of innovation

The BIRAC model of funding has helped in the emergence of several technologies. This has been limited to biotechnology companies over the years. However, it has to happen in every sector of research. Specific mandate has to be given to central and state government ministries to set-up funding mechanisms to pre-revenue companies. The magnitude of funding and restrictions on funding such as 70 : 30 ratio for consumables and manpower need a relook. In areas of high technology, individuals are the greatest assets. Funding limits have to be reassessed, especially for companies which are manufacturing-based.

Action: Cabinet direction to all ministries and state governments.

• Enabling ESCROW accounts in all social sectors

Technological solutions in the social sector have to be maintained for longer periods for public acceptability. This is possible only if the solutions provided are maintained over longer periods. This becomes impossible for many implementations as maintenance costs are not included usually. ESCROW accounts are expected to eliminate this problem.

Action: Finance Ministry to recommend the same.

• Showcasing products and entrepreneurs in national and international forums

There are no specific technological forums available to showcase Indian products, born out from Indian research. Such individuals and institutions have to be recognized through various mechanisms.

Action: DST may plan a showcasing activity and create mechanisms to promote individuals and institutions.

• Academic rewards for entrepreneurs

Entrepreneurs venture into unknown territory, taking up challenges and translating technologies to products. In many cases they fail, although they develop new understanding during the process. This could be used for academic rewards such as Ph D, M Phil, etc. and such mechanisms have to be entertained in institutions. Research degrees through entrepreneurships are possible in several institutions and this has to be nurtured nationally.

Action: MHRD directive to institution of higher education.

Direction

Direction may be short term or long term. We look into mechanisms that could help innovation today and tomorrow.

• Grand challenge initiative – SHAPE

SHAPE refers to Security, Healthcare, Agriculture, Pedagogy and Environment; these are the areas wherein an Indian Grand Challenges can shape the country's future and make a lasting impact through clearly defined goals and objectives. The nation must work on challenges for the future. Open innovation has scope, although certain direction is needed. Future innovations, interlinking institutions can happen with this direction.

Action: To be driven by the cabinet.

• National mission on scientific instrumentation

It is through indigenous instrumentation that the nation can progress. This has happened in specific sectors, but

Figure 2. A low-cost hand-held device for the identification of explosives at airports, developed at IIT Mumbai.

science instrumentation has kept itself away from taking roots in the country, despite initiatives. This mission should carefully nurture instrumental initiatives so that entrepreneurs emerge. About 80% of the project funds for research goes for equipment and most of it is imported. In equipment-building projects, at least five prototypes are to be built before the equipment reaches a state of high reliability. The primary goal of any academic/educational institution is manpower development and equipment creation will in fact develop more competent manpower and also help start-up companies.

Action: To be driven by the cabinet.

- National mission on medical instrumentation

Medical instruments reach the entire population. Medical science and research are two separate entities in the country. Almost no physician undertakes research. The interface between science/engineering and medicine has to be strengthened with active collaborations. As this is absent, many of those who need medical remedies are not in a position to access them, as instrumentation is developed without local inputs/components. One point can highlight the need of instrumentation in the area. While 1.5 lakh people require heart valve replacement each year, we are able to service only 45,000, due to the unaffordable price of this component. It is imperative to MAKE IN INDIA a high-quality heart valve and not be dependent on the only indigenous valve (Chitra valve), the technology of which is quarter of a century old. This is an extremely urgent and desperate situation and needs to be addressed with top priority.

Action: Initiate medical research in IITs, initially offering MD by research.

- Technology business incubators (TBIs) in all institutions

Business incubation has to become as important as technology development in all institutions where technology is being born. New mechanisms to fund these initiatives have to be established in all institutions. Institution-specific innovation forecasting must be a part of the activity of these centres. Innovation experts have to be employed to nurture budding ideas. Technology facilitation cells must be an integral part of these units.

Several of our technologies die in the laboratory as there are no institutional prototyping facilities at the right time, when the student or discoverer is available. This is critical in several cases, as the time of an individual to pursue a technology/product is limited during the course period.

Action: The Ministry of Commerce and Industry may partner with select institutions to set up TBIs. They have to develop as business units surviving on the revenue generated. TBIs to be established in all the institutions of higher learning in 5 years.

- Legal system

A major issue retarding entrepreneurship in academic institutions is conflict of interest. This needs to be resolved through legal assistance. Such support is often inaccessible or unavailable at reasonable cost and when needed. Legal mechanisms for individual support must be available in all institutions. This assistance goes far beyond company formation. It concerns with all aspects of legal support during the course of evolution of the company, interaction with businesses, protecting individual and institutional interests, venture funding, technology transfer, etc. in a business-friendly fashion.

Action: MHRD may come up with a well-framed conflict of interest policy on business incubation in academic institutions, and each institution may implement such a policy with institution-specific adjustments.

- Valuation of pre-revenue companies

Currently, when a financing institution evaluates a company for investment, it looks at profits, sales, fixed assets, balance sheets, etc. of the company. This would be a good model to assess revenue-making companies. However, for a start-up, the revenues are either zero or miniscule, as most of the funds are spent on technology/product development. Hence the doors of funding agencies such as Small Industries Development Bank of India (SIDBI) Venture Capital fund are closed, at least partially. Even if such a funding is available, the valuations are based on fixed assets and are outrageously low. It is clear that start-ups need risk-capital funding at a pre-revenue stage, particularly when they have developed a technology and are ready to expand.

Action: (a) Guidelines to be developed to assess the financial valuation of pre-revenue technology start-ups on the basis of IP & know-how developed, product/technology, strength of the team, future projections, etc. (b) These guidelines to be adopted by public/private risk-capital funding agencies, who have the mandate to invest in technology start-ups. Cabinet to act on the suggestions.

- Technology appreciation

The administration has to be aware of advanced technology available in various sectors. This is necessary to ensure that new research results reach the society. This appreciation must be done at the secretarial level. Formal platforms at this level have to be developed.

Action: Periodic technology appreciation meetings at various levels, in specific areas run by IITs.

- Statutory framework for sharing of ownership, technology, royalties

There has to be a uniform policy for government-owned or government-funded patents. Another approach may be used for collaborative R&D between laboratories, institutions and universities on the one hand and private companies on the other. Exclusive patents for commercial usage for limited period and non-exclusive patents for public purpose may be considered. Exceptional clause for intervention as a last resort could be introduced.

Action: MHRD to come up with an IP policy valid across institutions.

- Procurement/tender policy to accommodate incubated companies just as cooperatives

In sectors of social good such as clean water, health, environment, etc., implementation of technologies from academic institutions can happen only with government support. While there is a need to implement such technologies through government schemes, these technologies rarely get implemented at the grassroot level in the beginning, as the implementation process goes through the tender route. Incubated companies from academic institutions may be considered as cooperatives, as they are indeed partners for societal welfare. This may enable them to implement developing technologies without hard competition.

Action: Cabinet to approve new tendering policies.

Ministry-wise listing of recommendations

Central Government

1. National nanofabrication facility for small-scale manufacture.

2. BIRAC-type models in all sectors of innovation.
3. Grand challenge initiative for the nation.
4. National mission on scientific instrumentation, including medical instrumentation.
5. Guidelines for valuation of pre-revenue companies.
6. Procurement/tender policy modifications to accommodate incubated companies just as cooperatives.

Ministry of Human Resource Development

1. Creation of technology – social science interface.
2. Commercialization funds for social innovation.
3. Incorporation principles of sustainability in products and practices.
4. Enabling ESCROW accounts in all social sectors.
5. Academic rewards for entrepreneurs.
6. Technology business incubators in all institutions.
7. Legal system to nurture innovation.
8. Statutory framework for sharing of ownership, technology, royalties.

Ministry of Science and Technology

1. Interactive website – a window for problems and solutions.
2. Innovation in entrepreneur education.
3. Showcasing products and entrepreneurs in national and international forums.
4. Common centres for prototyping.

Ministry of Corporate Affairs

1. Corporate Social Responsibility funds for technology commercialization in rural India

Epilogue

India is at the threshold of translating socially relevant research to engines of social transformation. Many of these innovations may be frugal, but they have a huge scope, as our requirements are varied. Our institutions and human resource have to be prepared to absorb the scattered research results available across the country to tackle these varied necessities, and systems have be created to channelize the laboratory findings to economically viable and socially relevant innovations. The recommendations captured here as a result of a discussion meeting among technologists, academic-turned entrepreneurs, incubatees, administrators and like-minded individuals based on their experience in seeding and nurturing incubation culture, if implemented consciously, have the potential to transform the entrepreneurial landscape of our country.

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MEETING REPORT

Traditional ethnomedicinal knowledge of Indian tribes*

According to the Government of India 2011 census data, schedule tribe population in India is about 8.6% of the total population. This population is subjected to abject poverty and economic backwardness, often lacking in proper education and healthcare facilities. For healthcare, they mainly rely on traditional medicines that solely depend upon the supply of native medicinal plants. Their knowledge of tribal medicine (also known as 'folk' or 'indigenous' medicine) is mainly verbal, usually passed on from one generation to another without any written script, making documentation and record-keeping almost impossible. Studies suggest that the tribal and ethnic communities in India as part of their healthcare systems use more than 8000 species of plants and approximately 25,000 folk medicine-based formulations.

India harbours a rich repository of untapped medicinal plants, with plenty of associated knowledge that needs to be appropriately utilized. A conference on traditional medicinal knowledge was organized recently, which was attended by 80 participants, representing 12 states of the country. During three technical sessions, the following issues were discussed – the rising need to preserve the traditional medicinal knowledge of the country, legal protections (i.e. IRP-related issues) available to traditional healers, conservation of medicinal resources, cultivation of medicinally important plants, and translation of the traditional knowledge into drug development programme.

More than 1.5 million traditional medical practitioners in India use medicinal plants for preventive, promotional and curative purposes. About 65% of the Indian population relies upon traditional medicine for its healthcare needs. In his inaugural address, Palpu Pushpangadan, (formerly at National Botanical Research Institute, Lucknow) presented an in-depth analysis of the ethnobiological knowledge of the Indian tribes and possibilities of translating this knowledge in marketable pharmaceutical drugs. He mentioned that scientific validation, subsequent commercialization through patenting and licensing, and sharing of the benefits with stakeholders are crucial to the popularization of traditional medicinal knowledge. JEEVANI, an anti-ageing and anti-depressive drug developed from the Arrogyapacha (*Trichopus zeylanicus*) plant was an outcome of the traditional knowledge of the Kani tribes of Kerala. Therefore, the earnings from the drug

*A report on the three-day National Workshop cum Seminar organized by the Faculty of Science, Indira Gandhi National Tribal University, Amarkantak during 9–11 March 2015 on 'Frontiers in Ethnomedicinal Research: Traditional to Translational (FER-15)'. The event was supported by DST, DBT, NMPB, ICMR and MPCST.