CROSS FLOW OF TECHNOLOGY

REPORT OF THE WORKING GROUP FOR THE TWELFTH FIVE YEAR PLAN

2012-2017

Contents

Executive Summary

- Enabling faster socio-economic development, technology, is recognized today as one of the major resource in the country. Focus thus is on innovation and innovation that is employable and affordable. The cross-disciplinary research is being considered important in such a scenario. There is a need for cross-flow of technology not only to achieve research objectives but also to meet mega societal needs.

- Cross-flow refers to inter-sectoral and trans-sectoral flow of technologies to meet the defined end use. Cross-flow can be tuned to function as a lead vehicle to enable cross-use, and in the process, enable technologies from diverse domains address the needs of the society as a whole.

- Technological needs for the society vary and largely include food, water, health, energy, ecology, and environment. The structure of Indian R&D organizations is largely static and does not allow for smooth technological transfers across sectors. However, the country needs to rise from its transactional mode of operation to a relational mode.

- Several technologies that were developed by the players in Strategic and Civilian sectors have been utilized for economic development gainfully. With a few exceptions, these organizations operate within the ambit of pre-determined mandate, inflexible HR and financial policies, significant disconnect with the market, and an inherent tendency of attribution. Most of these factors deter a smooth cross-sector functioning, thus driving the need for effective cross-flow functioning mechanisms.

- The process of cross-flow can be enabled through transformation of knowledge institutions to a fluid-dynamic model that operates across boundaries, minimizes bureaucratic hierarchy and encourages functional clustering, ensures inculcating the feature of “core share facilities”, develops overarching mandates at government level, promotes innovative methods in human resource management that facilitates flexibility and mobility of individual and evolves newer financial models.

- While the concept of cross-flow has several merits, it also brings in certain challenges. Some notable concerns which can serve as bottlenecks for the cross-flow of technology might relate to creation of agencies that will have the capability of handling cross-use of technology, a participatory form of its governance, and regulatory and IPR issues associated with it.

- Working Group thus recommends a seamless interplay between the various technology development and implementing organizations and agencies in the strategic and civilian sectors. Evolution of a framework for enabling cross-flow would require strong institutional mechanisms on one hand and policy level interventions on the other. These could include:

  - Developing a Section 25 company as a nodal agency for management of cross-flow of technology in India that could coordinate between various technology institutions and stakeholders;
  - Initiating work plan on five identified cross-flow technology areas. These include:
    - Affordable health care – Establishment of Micro Public Health Care facilities through containers;
    - Agriculture – Mapping the soil productivity based on meta-genomics profile;
    - Natural resources – Enhancing potability of drinking water;
    - Environment – Waste management including recycling technology; and
    - Sensors – Smart-city development.
  - A spin-off from the mother entity as "for profit organization" to be created for each of the identified cross-flow areas. Profit share of the equity in these spin-offs would be ploughed back to the mother entity thereby sustaining the model;
  - A mission mode business model implementation should be undertaken. All the business entities including the mother entity should be run through professionally managed Boards of Directors;
  - Provide incentives for cross-flow and cross-use of technology over standard adoption and adaptation; and
  - Enhance capacity of translational facilities in order to modify, incubate and fine-tune technologies of a particular sector to make them effective elsewhere in a focused manner.

- The key responsibilities of the mother entity would be undertaking policy interventions to promote cross-flow, alteration and networking of organizations to facilitate cross-flow, strengthening the information backbone through creation of databases and strengthened ICT structure, developing innovative financial models, reorienting human resources through necessary interventions, focusing on R&D in cross-disciplinary technology areas and establishing new facilities using cross-flow of technology.

The Report of the Working Group

1. The Context

1.1 Changing Context of Technology

With the globalisation and increased focus on knowledge led economic development, technology is not only playing a key role but also has emerged as an enabling resource for generation of economic prosperity, international competitiveness and enhanced quality of life. Technology of the present era represents an ensemble rather than a unitary entity that comprise elements of a wide variety of R&D domains in varying proportions. In the present era of innovation, technology can only enable technology.

Cross-disciplinary research has emerged as a key towards development of all modern technologies. In its endeavour of achieving faster and more inclusive growth during the 11th Five Year Plan, this cross-disciplinary input for technology development was appreciated. It was felt that "a seamless and multi-sectoral flow of technology and inputs of scientists and engineers from various disciplines is essential for making a visible societal impact and economic prosperity". In this context, a Working Group of the Planning Commission identified S&T areas cutting across traditional divides of science, engineering and medicine where investments could pay rich dividends.

Learning from the past, it is felt that the key for enhancing technological competitiveness of the country was not merely to catalyse cross-disciplinary R&D domains but to put in place mechanisms that enable cross-flow of such technology, transform institutions to enable them absorb and assimilate such dynamics, and develop models to promote large scale technological diffusion. Furthermore, the focus of the Plan initiative should be to enable application of the concept of cross flow of technology to address a few identified problems of national priority.

Cross-flow refers to inter-sectoral and trans-sectoral utilization of technologies to meet end use such as societal gains. Cross-flow can be tuned to function as a lead vehicle to enable cross-use, and in the process, enable technologies from diverse domains address the needs of the society as a whole. Thus the context for the present Working Group was to recommend evolving of these structures, and suggest methodologies for utilising them appropriately, keeping in view the specific requirement of diverse sectors.

1.2 Technological Evolution – From a Precision Tool to a Social Enabler

The key to the changing context for technology has been the metamorphosis of the character of technology itself. During the post Industrial Revolution period, technology was essentially a precision tool that improved productivity in the manufacturing sector in various ways. As decades passed and the structure of the

economy underwent radical transformation with increasing dominance of the service sector, technology evolved faster than ever. Soon it transformed into a social enabler. Information and Communication technologies (ICT) represented one of the most noteworthy domains in this front. This enabling role of technology towards society has been the chief propellant for its emergence as a vehicle for facilitating inclusive economic development envisaged in the Five Year Plans.

1.3 National Technological Framework

The national policy framework for technology is centered on the Technology Policy Statement. The statement mentions about the need of technological development and application to industrial and social sectors. It further highlights the need for technology acquisition, absorption and transfer among diverse sectors in order to ensure that India attains technological self-reliance at an early date. The resolution however makes no explicit or implicit mention about the concept of cross flow of technologies among sectors as a process of acquiring technological maturity.

2. The Need

2.1 Sector-Specific Technological Needs in India

Technological needs for the society are diverse and span across various sectors, highlighting the need for a cross-flow of technologies. These sectors cover food, water, health, transport, communication, energy, etc. An illustrative list of technologies required by various sectors could be use of state-of the art medical devices & vaccines; desalination & water purification technologies, nutrition; appropriate housing technologies, natural disaster forecasting and advanced computing, manufacturing engineering, industrial and transport automation, functional materials and MEMS, energetic material research, ultrasensitive sensors and auto controlling devices, thin films and terahertz devices, security technologies etc.

2.2 Streamlining Technological Flow – New Paradigms in Old Structures

Fostering cross-flow of technologies among sectors raises a new difficulty in Indian organizational structures. As the innovative performance of a country depends to a large extent on how its various institutions relate to each other as components of a collective system for knowledge creation and its proper dissemination to value added technology, mechanisms are needed to be evolved in order to streamline technology flow that facilitates innovation. There is a growing need to conduct R&D and provide technologies in a transactional mode.

Changing organizational structures to bring in cross-flow is not a practical solution. Effective cross flow would therefore warrant devising mechanisms that enable operation of the new paradigms within the existing structural contexts. This could be achieved through bringing in certain interventions such as:

- Job enrichment and job enlargement as HRD practices in organizations;

- Increased emphasis on employee training;
- Establishing functional network of organizations that are driven more by shared goals and objectives;
- Adopt a plug-and-play model for implementing innovation; and
- Circumvent redundant organizational processes through adoption of crowd sourcing and Science 2.0 approaches.

3. The Institutions

3.1 Structure of our Technology Institutions

Several research institutions under the aegis of various scientific departments have been striving to develop and nurture scientific research at the highest level to address societal needs. It is therefore important to bring in synergy to the diverse tasks undertaken and enable solutions that can benefit the population at large. Typically organizations operate within the ambit of pre-determined mandate, inflexible HR and financial policies, significant disconnect with the market, and an inherent tendency of attribution. Most of the organizations have relatively hierarchical organizational structures, formalized flow of commands, and assigned work schedules. Such features do not promote smooth cross-flow and synergy essential towards effective technology development and use.

Therefore, it is envisaged that a synergistic approach is necessary to cut across individual scientific organizations' technical core competence and orient it for transferring research led technological innovation for direct societal gains.

3.2 The Big Players in Strategic Sectors – Defence, Space, Atomic Energy

The major players of the Strategic Sector are Defence, Atomic Energy and Space. They possess some technologies that could be used for the benefit of the civilian sector. Such technologies should be identified for cross-flow and cross-use. Each of these sectors individually have over the years developed and established world-class scientific and technologically competitiveness in their respective areas particularly relating to Defence and allied services, Nuclear Science and Engineering, Space missions and remote sensing technologies..

3.3 The Players in the Civilian Sector

The players in the civilian sector include the Ministries of Science & Technology (along with their departments), Earth Sciences, and Health and Family Welfare. They have their set ups which include battery of national laboratories. These laboratories have developed over the years a number of technologies that have been utilized for economic development gainfully. Some of these technologies should be further identified for cross-flow and cross-use. The aforesaid ministries/departments along with various other ministries have played a pivotal role in the overall upliftment in the living standards of people by providing value and free primary education to all, enhanced agricultural production by employing advanced scientific practices and efficient health care services to one and all.

4. The Mechanisms

4.1 Metamorphosis of our Institutions for Cross Flow and Synergy

Traditional organizational setup in India has relied upon delivering manageable chunks of the entire work package and is in a way too focussed in their own particular area or business. This in many cases offsets the common goal, and has limited outreach. In order to address the social issues of the country, the Institutions need to align themselves in such a way that the local actions are executed in accordance with the collective vision. This calls for some changes in our institutions that could be achieved through one or more of the following processes:

- Transformation of knowledge institutions to a fluid-dynamic model that relies more on shared goals and operates across boundaries;
- Minimize bureaucratic hierarchy and encourage functional clustering;
- Ensure greater permeability in using the available resources thereby inculcating the feature of “core share facilities”;
- Develop overarching mandates at government level that cut across the limited mandates of individual organizations;
- Promote innovative methods in human resource management that facilitates flexibility and mobility of individual e.g. dual appointments; plug-and-play associations etc.; and
- Evolve newer financial models.

4.2 Achieving Cross-Flow through Cross-Use

A favourable approach to achieving cross-flow would be to nurture the core competencies present in-house, exploit complementary strengths present elsewhere and cross-use them through a planned cross-flow networking.

India has already made use of cross-use in informal ways. However, scattered examples of the cross-use of technologies have failed to evolve a framework by means of which such processes could be effectively replicated elsewhere.

4.3 Participatory Models in Technology Diffusion

Technology diffusion in a broader sense would signify transfer of innovation from the inventor/ supplier to the user or from a user to another potential user who would be benefitted. Various models of technology diffusion have been defined. However, the participatory model, in which the end-users of the technology are engaged from the very inception stage, has been found to be the most effective.

In order to sustain the cross-flow and to ensure that it results in the envisaged benefits, a participatory model is suggested. This would encompass involving the end-users in the chain right from the start by taking into consideration their priorities, developing technology through large-scale networking and reverting to

them with the success of modified innovation, very similar to the '*Farmer-First-and-Last'* approach taken in Africa to develop enhanced agricultural production.

4.4 Connecting Subsystems through Cross-Flow

Evolution of a framework for enabling cross-flow would require strong institutional mechanisms on one hand and policy level interventions on the other. These could include:

- Developing nodal organization for management of cross-flow of technology in India that could coordinate between various technology institutions and stakeholders;
- Establish a database of technology identified for cross-flow – such technology could be available with different institutions;
- Create an inventory of (technology)cross-flow requirement of various sectors;
- Provide incentives for cross-flow and cross-use of technology over standard adoption and adaptation; and
- Enhance capacity of translational facilities in order to modify, incubate and fine-tune technologies of a particular sector to make them effective elsewhere in a focused manner.

4.5 Leveraging Strength through Pooling of Resources

The multi-sectoral structure of India's technological institutions has led to a substantial element of duplication of efforts in addressing key problems. Such duplication is visible not only between strategic and non-strategic sectors, but also between the various players of the individual sectors. One of the key issues to maximise technological prowess is to identify and document such duplications, and pool such resources through cross flow mechanisms. This could be achieved by one or more of the following ways:

- **Pooling of the IPR portfolio from various organizations** – this would give a comprehensive portfolio of foreground and background IPRs that could be effectively leveraged for technology commercialization, which would not have been possible singly.

- **Pooling of expertise to build technology mission projects** – pooling of scientific talents from various organizations cutting across sectors could be instrumental in generating a combined technological base that can effectively contribute towards building large and focused mission projects such as the ones on water or energy.

- Consultative committees across various sectors e.g. defence, space, agriculture, science & technology etc could be effective in identifying and developing appropriate mechanisms for leveraging joint strengths.

4.6 Micro, Small and Medium Enterprises: Role in Cross Flow of Technology

The Micro, Small and Medium Enterprises (MSME) in India represent a highly heterogeneous sector in terms of their individual size, strength and capacity. Of the approximate 26 million enterprises across the country, around 19% cater to manufacturing output related to food products, 15% cater to garments, 8%to chemical and chemical products and rest cater to machinery and transport equipments, rubber, plastic, furniture, paper and leather products. Thus, it is imperative that this sector, which has a direct outreach to the society in a holistic manner, should play an important role in cross flow of technology.

Two lines of analyses can emerge out of this, the first being more obvious, as to how MSMEs can help in cross-flow and cross-use of technology and secondly how can cross flow technologically uplift them to be globally competitive while retaining the international compliances. Important operational and policy issues however would need to be addressed in both the scenarios. These could be the following:

- Small size of MSME and their relative organizational fluidity would often become an impediment in absorbing the advanced and complex technologies that originate from the strategic sector. Thus, “intermediary technology spacers” need to be put in place to effectively transact technology with MSMEs.
- MSMEs often have sub-critical manpower with limited technical competence. Thus, “mentors” need to be identified appropriately for bringing MSMEs at a level that make them equipped to transact with strategic sector players. Such mentors could be either individuals or organizations.
- Financial models that are evolved for technological transactions with MSMEs need to be innovative, risk-absorbing and open-ended.
- Creation of companies with equity participation from the government.

5. The Issues

Cross-flow of technologies involving strategic and non-strategic sectors is associated with important regulatory and IPR issues. Such issues need to be kept in mind while devising mechanisms that aid in the cross-flow process.

5.1 Regulatory Issues Associated with Cross-Flow of Technologies

A significant portion of strategic technologies available with Atomic Energy, Space and Defence have direct bearing with national security. Thus, while some of the component technologies could be used safely by the civilian sector without compromising on the security issues, many are not. It is imperative that such components should be defined and delineated at the outset and summarily kept outside the purview of cross flow.

Technologies related to atomic energy are often endowed with uncompromising safety concerns. Many of the safety guidelines associated with the use of atomic energy are difficult to implement in the civilian sector. Framework is needed to be put in place in order to effectively regulate use of atomic energy through cross-flow.

Addressing such concerns and scenarios require a clearly defined regulatory framework for governing cross flow of technology. The framework could address the following:

- To determine the types of technologies that could be cross-flowed and the ones that are not;
- To delineate the safety considerations associated with cross-flow of technologies;
- To identify implementing modalities to ensure safe use of cross-flow of technologies; and
- To provide legislative framework towards governing cross-flow of technologies in India.

5.2 IPR Issues Associated with Cross-Flow of Technologies

Issues related to intellectual property rights also constitute an area of concern, particularly in view of the fact that multiple sectors are involved in the process. Cross-flow is likely to use technologies (including proprietary technologies) developed and owned by diverse sectors. Incubation and adaptation of such technologies by other sectors would result in products and technologies that could themselves be proprietary in nature. It would therefore be important to develop a mechanism that would fix the ownership of IPRs for downstream products and technologies that have been developed out of proprietary technologies as a result of cross-flow.

6. Focusing on R&D in Cross-Disciplinary Technology Areas

The Working Group has identified five premier areas where enabling cross-use of technology could bring about the implementation of cross-flow of technology. The areas are:

6.1 Mapping soil productivity through metagenomic analysis

Finding the best means to have enhanced quality agriculture requires till now more of experimentation, hands-on skills, knowledge from previous experiences and even sometimes trial and error methods. With the on-going developments based on R&D towards understanding the genomic profile of soils, much has been the transformation in improving soil productivity. While macro analysis boosts a small increase in productivity, the micro level soil analysis and creation of databases on soil resources would help augment a more precise and product oriented agriculture. It would also be useful to study and prevent soil mass loss due to erosion. Technologies developed in a multitude of sectors such as ICAR

fine-tuned through participatory models would leverage in area/ zone based soil productivity. Satellite imaging, remote sensing applications related to topography mapping and environmental analysis from ISRO, coupled with CSIR expertise on root biology and metagenomic analysis would result in generation of new knowledge that can be well utilized for creation of agricultural wealth.

6.2 Micro Public Health Centre (PHC)

Driven by the commitment towards the goal of "Affordable Health for All", India has seen several improvements in the medical heath scenario with enhanced disease diagnostic facilities, better knowledge-base, competitive pharmaceutical market and mushrooming of medical insurance providers. However India still lags behind at a whopping number at 139 out of 194 countries, listed by United Nations, having life expectancy at ~65 years with Japan being at no. 1 with 83 years. The telemedicine facility approach is one such initiative where remote District Hospitals/Health Centres are connected to the Super Specialty Hospitals in cities, thereby providing quick remedial solutions to the patients. In this direction is a recommendation of the Working Group – the Creation of Micro Public Health Centre (Micro PHC). Data generation and meta-analysis for convergence of data and containers-transformed public health centres will be the back-bone for enabling affordable healthcare through this initiative. Health cloud computing managed through satellite and reaching directly to the rural people is suggested in this initiative. Epidemiological and other relevant clinical data generation through ICMR, the application of R&D towards point-of care biomedical instrumentation, especially zero cost diagnostic systems through CSIR, DST, DBT etc., and satellite support and remote sensing technologies through ISRO and data analysis through the Fourth Paradigm initiative can come together through the cross-flow of technology to provide affordable healthcare for all.

6.3 Enhancing the Potability of Water

Despite the national missions taken by the Govt. to create awareness and provision of safe-drinking drinking water for 'one and all', the country still stands at a disdainful position among others when it comes to quality potable water. One of these sources of utilisation of water comes from ground-water resources. Levels of heavy rainfall practically occur at a very short period of time (mostly between July-September) and have been distributed erratically. This coupled with unplanned and bountiful ground-water extraction for irrigation have posed a threat in letting India become a water starved nation. In order to crack down the problem of deficiency of water, the vast stretch of coast-line in India having an inexhaustible source of water supply, though all of it is saline, should be exploited. Desalination technologies, currently available in individual packages, can help convert this saline water into salt free water ready for consumption. Economic viability of desalination technologies efficient to providing safe water free from hazardous elements or microbial contamination is a matter of concern. Further to treatment technologies, efficient mapping of prospective water zones through hydro-geological and geophysical studies should be periodically updated to avert a crisis situation. Better means of storage of rain water through proper harvesting techniques, identification of areas where there has been consistent decrease of water table and creation of technologically developed structures as a means of

artificial recharge of ground water reservoir are needed for "wise management" of water. The various activities from different departments and ministries towards potable drinking water may be synergized through cross-flow to help reduce redundancy of efforts and improve mechanisms for successful implementation of technologies useful in the area.

6.4 Waste management and recycling technology

Generation of wastes has been dis-proportionate with the boom in urbanization and modernization of daily life activities causing a serious threat to the ecology and environment. Waste management is an ensemble of proper collection, transport, disposal and in many cases economic processing of domestic and industrial wastes. Waste management typically varies with the type of waste and with the societal establishments at a smaller scale to different geographical locations at a wider magnitude. High end technologies that would be able to handle and manage all types of wastes generated in urban and rural environments are still yet to make headway. Installing plants enriching the technical competency, selection of proper site for landfills, better means of transporting etc., have to run in a symbiotic fashion for an efficient municipal solid waste management system. Even landfills do pose serious threats particularly in the case of e-waste where leached out lead, mercury and other toxic metals contaminates the soil and groundwater sources. Unethical practices of shipping e-waste overseas to countries where they will be reused and again in a cyclic fashion marketed to the whole world with the contaminated products should be under proper regulations. Waste management is one of the sectors where diverse laboratory/ institutions' knowledgebase and stakeholders/ industries' effective planning and design strategies would fructify the concept of 3R's (Reduce, Reuse and Recycle) in waste management through an effective cross-flow of technology.

6.5 Smart City

Traditionally the idea of a "Smart City" or an "Intelligent City" has been revolutionized with a bountiful number of ideas in a similar way as a painter brushes with an infinite number of colours which is the reason that a single definition of a smart city is yet to evolve. The vision of a smart city could be imagined to be a city where each and every person starting from the service provider to the user will have easy access to seamless flow of information. It could be visualised as a large virtual "Urban OS" (operating system) where the economies of scope through the operation of a multiple number of like-minded entities can be maximized. These types of cities would be instrumental to utilize and transform all its available resources by leveraging through real time data collection and prompt action by installing numerous sensors and controls. One of the key areas where transformation can be visualised are smart traffic control systems to avert heavy traffic during different hours of the day depending on road congestion statistics, thereby having wise management of the infrastructure facilities also. Remote sensing operations to help critically and chronically ill patients through telemedicine facilities and recovering the data back through proper tools. Smart GIS/ GPRS based application systems including smart surveillance cameras to avert and alert travelling persons including police personnel from possible natural calamity or harmonal discord in a particular area/

zone. Prior information to anyone through telematics to have a prior knowledge of say shopping time, congestion, queue at public places, parking availability and so on. The platform to these smart systems lies in the ubiquitous presence and generation of data collected, studying and planning for futuristic projects from a solid backbone of ICT services.

The Working Group felt that the idea of implementing a smart city in India could be one of the major achievements for showcasing effective cross-flow of technology. Data generated from this place by way of mobile phones and other sensors installed in several devices would be collected and backhauled to the central processing agency where the data would be analysed and responses would be generated and disseminated like cloud computing. For effective implementation, the initiative towards Smart City will be dependent on the cross-flow of technology from different sectors and departments/ministries.

7. The Recommendations

The Working Group on Cross-Flow of Technologies discussed and deliberated at length the issues and challenges associated with the domain. The Working Group felt that cross-flow of technology could be effectively utilized provided the mechanism could be focussed towards addressing a few problems of national priority. The recommendations of the Working Group are given below:

7.1 Mechanism

- **Undertaking Policy Interventions to Promote Cross-Flow:**
    - The Working Group recommends delineating overarching mandates that cover 'sectors' rather than 'institutions'. Such mandates should be specific and focus upon technological deliverables, and also highlight the specific roles individual organizations are envisaged to play.
    - A Section 25 Company for management of cross-flow of technologies be formed and designated to function in ownership and close coordination with the identified scientific agencies/departments of the strategic and civilian sectors.
    - Special incentives should be provided for cross-flow and cross-use of technologies by stakeholders. Such incentives could cover financial and non-financial aspects.

- **Enabling Organizations to Facilitate Cross-Flow:**
    - The Working Group recommends that knowledge organizations to achieve identified objectives could represent a more fluid dynamic model that relies on shared goals and operates beyond their physical boundaries to develop appropriate connectivity;
    - The Working Group recommends large scale networking of organizations from various sectors. Such networking should not be restricted only to R&D institutions but also cover the wider cross-sections including academic institutions, universities and industries.

- The Working Group recommends that the organizations identified for facilitating cross-flow should be endowed with newer and innovative HR practices such as matrix management, job-enrichment and job-enlargement, employee training and continued education.
- The Working Group recommends that innovative entities such as "intermediary technology spacers" and "mentor organizations" be identified to facilitate the process of transfer of a technology from cross-flow to MSMEs. A Task Force might be constituted to look into the modalities of establishing such machinery and the required policy-making.
- The Working Group feels that pooling of resources in terms of IPRs and individual/organizational expertise in identified domains and evolving synergies through establishment of consultative committees covering multiple sectors could be effective in leveraging the technological capabilities of the country.

- **Strengthening the Information Backbone:**

  - The Working Group recommends creating a database of technologies identified for cross-flow at the national level covering all sectors.
  - It is recommended that the national ICT infrastructure should be enlarged, strengthened and networked more extensively. The ambit of the National Knowledge Network (NKN) should be extended to reach to a wider section of institutions.
  - The Working Group strongly recommends that the Government might set up a National e-Science Cross-Flow Portal for facilitating cross flow of technologies.

- **Developing Innovative Financial Models:**

  - Incentivizing cross-flow of technology would require establishing newer and innovative financial models. The Working Group recommends that models for financing cross-flow of technologies should be innovative, risk absorbing and without the conventional controls.
  - The Working Group recommends that upto 10% of the Plan funds provided to scientific and allied ministries involved with technology development such as DAE, DOS, DST, CSIR, DBT, DIT, ICMR and ICAR be specifically earmarked for focusing on cross-flow of technologies.
  - The Working Group recommends setting up of Section 25 company with equity participation of the government upto 49% and rest from private investments. The specific areas identified for cross-flow may be undertaken by "for profit spin-offs" that would be created under the mother company.

- **Reorienting Human Resources through necessary interventions:**

  - The Working Group recommends technology organizations to adopt innovative human resource management procedures to facilitate cross-flow. Such practices could include:

- Evolution of plug-and-play models;
- Facilitate mobility of individuals between organizations;
- Evolve newer modalities such as dual appointments; and
- Identify Cross Organizational Relationship Persons (CORPS) from individual organizations to focus on the objective of achieving cross flow.

7.2 Cross-Disciplinary Technology Areas

Meaningful cross-flow and cross-use of technology could only be achieved if there is a significant portfolio of cross-disciplinary R&D achievements in specified sectors. The Working Group therefore stresses the need to focus on R&D efforts in diverse sectors which can eventually be funneled through organizational mechanisms to enable cross-flow.

It is suggested that the following cross-disciplinary R&D areas be given adequate attention in the 12th Five Year Plan (Details as in segment 6):

- Affordable health care – Establishment of micro Public Health care through containers.
- Agriculture – Mapping the soil productivity based on meta-genomics profile.
- Natural resources – Enhancing potability of water.
- Environment – Waste management including recycling technology.
- Sensors – Smart-city development.

7.3 Programme Implementation Strategy

Cross flow of technology could be effectively achieved only if there is a well-focused business model linked to the project implementation strategy. In this regard, the conventional modes of inter-ministerial operations in the strategic and non-strategic sectors may not prove effective. It emphasized on adopting a corporate-like approach towards addressing the issue. In this context, the following modality was suggested:

- The Working Group recommended that the implementable technologies through cross-flow could be scouted and managed through a dedicated Section 25 company (with equity participation) created for the purpose. Such a company, which would function as a “mother entity”, would spin off “for profit companies” in each of the identified technological domains. Profit share of the equity in these spin-offs would be ploughed back to the mother entity thereby sustaining the model.
- The Working Group suggested that the mother entity could begin with a small equity base in which all the participating departments could contribute in a pre-determined proportion. The Working Group further suggested that the business entities could explore the possibility of soft loans from various sources.
- The Working Group recommended that the cross flow companies would have managed portals that would provide information regarding HR,

technology and IPR portfolio associated with the identified technology domain. It was felt that this activity could be entrusted to the mother entity.

- The Working Group suggested that a mission mode business model implementation be undertaken. All the business entities including the mother entity should be run through professionally managed Boards of Directors.

A brief of the plan on setting up of a company to achieve the Cross-flow of technology, as suggested by CII and CSIR, is detailed below:

National Cross- Flow Technology Deployment Corporation (N*cf*TDC)

Objective

Deployment of Cross-Flow Technologies in the areas of national priorities / solving challenges the country is facing through multi-institutional PPP alliances, in the country.

The Parent Company

Proposed National Cross-Flow Technology Deployment Corporation will be the parent company and will be incorporated as a Section 25 Company promoted jointly by CSIR and CII with an initial authorized capital of Rs. 10 cr. with equity participation by CII (of 5.1 Cr. – 51%) and CSIR (of 4.9 Cr. - 49%).

Subsidiary Companies (Technology Deployment Alliances – TDAs)

Initially, the parent company, NcfTDC will incorporate five subsidiary companies (section 25):

1) Technology Deployment Alliance – Agriculture
2) Technology Deployment Alliance – Healthcare
3) Technology Deployment Alliance – Water
4) Technology Deployment Alliance – Environment
5) Technology Deployment Alliance – Infrastructure

In each of these subsidiary companies, the parent company will hold 51% share by investing Rs. 1.02 crore and the balance 41% (Rs. 98 lakhs) will be invested by the respective Government departments and private sectors thus each subsidiary company will have initial authorized capital of Rs. 2 crore.

First Projects

Five TDAs will deploy following demonstration projects (of scalable size) in 2/3 years time frame, respectively.

1) Soil Productivity
2) Micro Public Healthcare System
3) Portable Drinking Water
4) Waste Management and Recycling
5) Smart City

Finances

For each of the above project, consortiums of public and private sectors will be created and detailed Project Report with budgetary estimate will be prepared. Funding for projects will be sourced from respective government departments/ institutions (not more than 49%) and from private sectors (not less than 51%). Project Management Fees (in the range of 5-10% of the project costs) will be charged by these Subsidiary companies and will be included in the project cost.

Management & Operations

- Both Parent company and subsidiary companies will have Board of Directors (Representatives from promoters, Industry, Financial Institutions and Govt. organizations) and will have core teams of professionals and CEOs working from a rented office premises
- Each TDA will have Core Project Management Group (Full time Project Management Professionals, Scientist from relevant labs/institutions and industry personnel) who will be responsible for end to end i.e. preparing Detailed Project Report till establishment and stabilization of operations including preparing a scalable/replicable business plan to cover the entire nation.
- The fixed cost of the manpower and office expenditure of all the companies (Parent company and its five subsidiaries) will be met from the earnings in the form of project management fees/royalty.

Expected outcomes

- Cross-flow technology partnership ecosystem
- Scalable /Replicable Business Models
- Policy Framework / incentives to support replication

7.4 Recommended Budget

(Rs. in crore)

S. No.	Head	Budget 2012-17
1.	Data Networks and Data Warehousing	50.00
2.	Grant-in-Aid to Mentor Organizations	100.00
3.	Funds for Technology Assessment and Adoption	50.00
4.	Seed money for Technology Venture Fund	200.00
5.	Training of Engineers/Scientists/ Stakeholders on Cross Flow of Technology	20.00
6.	Collaboration and Networking (including international collaboration)	80.00
7.	Funding for R&D in Cross-Disciplinary Areas	200.00
8.	New Facilities using Cross Flow	
8.1	Micro PHC	50.00
8.2	Rural Technology Classrooms	50.00
8.3	MSME Virtual Incubators and Tool Rooms	25.00
8.4	Innovative Automobiles	25.00
	Grand Total	**850.00**