Shaping the National Innovation System: The Indian Perspective

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Innovation in India is becoming a part of public discussions, business forums, and media announcements more often than it did in the past. However, the term 'innovation' carries multiple meanings, and is often used in the narrow context of short-term relevance. This usage is so frequent that even a temporary solution—which could be considered a 'work-around' or 'Jugaad', as it is known in India—carried out to overcome serious inadequacies of a system is praised as innovation (see Box 1).

What 'innovation' means in India

Thus the answer to any question about 'innovativeness' in India varies considerably, depending on the sector and the context under discussion. Many analysts, business planners, and researchers now recognize that macro indicators—such as national investment in research and development (R&D) (also known as gross expenditure in R&D, or GERD), R&D expenditure by industry as a percentage of sales turnover, the patents filed in a year, or number of research papers and number of PhDs in science and engineering, for example—are inadequate to capture the realities of innovation system in India. These indicators alone are not sufficient to provide policy makers with the necessary evidence to take concrete actions to stimulate and accelerate innovation in academia and the industry, agriculture, and services sectors.

Multiple elements need to be considered in totality in order to address the challenges of innovation. It will not suffice to address a few specific elements—such as tax incentives, additional funds for R&D, or excellence in education—regardless of how important they each are, in isolation. Recently attempts have been made to understand Indian innovation. One of the experts in this area, Arun Maira,[1] has aptly described the struggles that Indian policy makers and leaders in innovation have experienced over the last 10 years (see Box 2).

The Indian innovation system is extremely complex in terms of user segments and income disparities, and therefore markets are highly differentiated. At the same time, parts of some sectors need to cater to global demands. In order to focus our ideas on the complexities and their interconnected linkages, Table 1 provides a simplified diagram that attempts to capture most of the crucial elements of the Indian innovation system.

Although there have been a number of successes over the past two decades in some elements of Block 3 of the figure, and the successes have increased in the last decade, solutions that originated in India (the final outcomes shown in Block 4 of the figure) are very limited.

Policy (shown in Block 1 of Table 1) does not merely mean white papers or resolutions or even

Box 1: Jugaad: A nuanced term

There exists no colloquial word in Indian languages for 'Innovation'. Jugaad in India is pejorative, as is Gambiarra in Brazil and Zizhu Chuangxin in China. Yet emerging market problem-solving is becoming exemplary. India could give the world a new form of innovation, just as in 1966, India gave the world, Yoga, Sitar and Carnatic Music.

SOURCE: R. Gopalakrishnan, Director, Tata Sons, Sons, personal communication, 2 May 2012.

The author gratefully acknowledges the contributions of all the people who have assisted in this work. Special thanks go to Mr. Arun Maira, Member, Planning Commission, and Mr. R. Gopalakrishnan, Director, Tata Sons, for providing their thoughts and insights to this piece. The author wholeheartedly welcomes contributions from Dr. Goutam Muhuri, President, R&D – Dosage Forms, Jubilant; Mr. Hrridaysh Deshpande, Director, DYPDC; Mr. R. Saha, Senior Advisor, CII; Mukesh Mathur, Scientist D, TIFAC-DST; and Sajid Mubashir, Scientist F, TIFAC-DST in the areas of Pharma, Design, IPR and various DST initiatives, respectively. The author thanks Mr. Anjan Das, Executive Director, Technology, and Ms. Seema Gupta, Director, CII, for providing necessary contacts and sharing thoughts. Last but not least, the author gratefully acknowledges the assistance of Mr. Jibak Dasgupta, Deputy Director, CII, for providing insight, collating all the information, helping shape the chapter to its current form, and editing as and when required.

Box 2: An innovator's struggle

Indian policy-makers and leaders in innovation have been experiencing an innovator's struggle in the past ten years. Since the innovator's idea is different from the prevalent dominant idea, it is dismissed, or not even noticed. A new paradigm of innovation has been growing in India: with a focus on simplicity and frugality in the process of innovation itself in contrast to the dominant paradigm wherein innovation is expensive and requires large resources of highly qualified personnel and finance and facilities. In the dominant paradigm, the principal, or even only measures of the innovation capacity of a system were the amounts spent on R&D, the numbers of scientists engaged, and the numbers of patents produced. Whereas in the new paradigm of innovation that has emerged in India, the measures of a system's innovation capability lie in the production of solutions (products and services) that are affordable and accessible to people with very low incomes. In this paradigm, innovations are outside the laboratory mostly. They are in institutional and organizational innovations that enable co-creation and co-operation to create reach, reduce costs, and deliver solutions that are useful to masses of people at the 'bottom of the pyramid'. This paradigm of innovation is being acknowledged now as a legitimate and useful innovation. Policy-makers charged with stimulating a system's innovation capacity, and evaluators of international innovation capabilities need to factor in insights from this emerging paradigm and replace conventional views.

SOURCE: Arun Maira, National Innovation Council, personal communication, 5 May 2012.

legislation, but should cover the whole chain of implementation to the last block in the figure. In many instances, the policy of government ministries promotes the development of new products and services by industry or government research labs, but, simultaneously, government purchasing policy in other ministries inhibits products from being developed through indigenous R&D. Similarly, many government bodies that approve test results or quality processes or certification are either ill equipped or mired in archaic procedures. In a number of instances, variations in standards from state to state affect certification. All these elements or drivers, shown in Block 1 of the figure, must be addressed.

The 4th driver shown in Block 1 is finance; finance is the first element in Block 2, facilitators, and appears there as government funding bodies. The only specific banks or venture capital funds shown in this block are the Small Industries Development Bank of India (SIDBI) and the National Bank of Agriculture and Rural Development (NABARD). This is because the policies and processes in place for financing innovation by banks and venture capital funds are highly skewed towards commercial and foreign consultant–backed ventures; this problem needs serious attention.

Similarly, the elements of Block 3 of the figure, which comprise the intermediate outcomes, show serious disconnects that prevent them from moving towards Block 4, the final outcomes. For example, most publications from even elite science and technology (S&T) institutions are not even vaguely oriented towards solutions. Even for those few that do attempt solutions, there is no follow up by the groups or institutions involved. Similarly, most patents are not commercially viable. Many of these patents result from the policies of funding S&T departments, national science academies, and the personal/promotion policies of research institutions that often work against those scientists/academics who work for marketable solutions, start-ups, prototypes, demo services (except when they are provided by big companies). They often flounder because of a lack of government or private-sector funding. The facilitation mechanisms shown in Block 2 of the figure are often too poorly funded or too small to cater to a large number of such intermediate outcomes, which in turn must evolve into the Block 4 outcomes shown in the figure.

It is beyond the scope of this chapter to deal with each of the elements depicted in Table 1 in detail. Hence the following section provides an overview of the actual Indian innovation scenario and illustrates a few select industrial sectors in which Indian innovation activity is relatively high. In the process we also point out areas of serious gaps. One of these is the gap in the innovative ability of micro, small, and medium enterprises (MSMEs), which is important in the medium- and long-term interest of the Indian economy and society because these enterprises provide employment for millions of Indians. The chapter provides a view of some of the thriving 'green gardens' of the Indian innovation system and also some of the 'dry desert' areas needing innovative attention.

In the following section, we take stock of some innovation-facilitating mechanisms and driving factors. These range from government finance systems, hand-holding systems that work with the innovators at every stage until they mature, and intellectual property rights (IPR)

Table 1: Idea-to-market curve

Drivers (Block1)	Facilitators (Block 2)	Intermediate Outcomes (Block 3)	Final Outcomes (Block 4)
1. Policy 2. Procedures for implementation 3. Knowledge inputs/access 4. Finance	**1. Government funding bodies** *Examples:* DST, DBT, TDB, TIFAC, NSTEDB, SIDBI, and NABARD. Ministries have some upgraded funds. **2. Technology R&D centres** *Examples*: Central government-funded national laboratories such as CSIR, ICAR, DAE, DRDO, ISRO, CPRI, CMTI, and so on. About 300 such centres exist in India. Industrial R&D centres including in-house R&D units, SIROs (NGO), foreign R&D units or centres, elite institutions, such as IITs, IISc, NITs, and central universities **3. Certification/standard approval and other formal accreditations** *Examples*: BIS, RDSO, food and drug controllers, national testing laboratories, IPO (for patent, design, and other IP components)	• Publications • Patents • New designs • Performance improvement in existing products/services • Start-ups • Skill upgrades • Joint R&D projects • Prototypes • Demonstration services • Technology-intensive products and services made in India	Production of solutions (products and services) that are affordable and accessible to: • People with very low incomes • People in the middle class • People in aspiring upward mobile classes Products and services distributed to global markets

Note: See Annex 1 at the end of this chapter for all acronyms.

facilitation to design-related support, to name a few. We also address macro indicators of innovation such as technology intensity in Indian manufactured exports, and compare these indicators in India with those of a few other countries.

Pockets of excellence

As can be guessed by any discerning observer of the Indian innovation system, although a number of pockets of excellence have emerged over the last several decades, there are few interconnections among them even at the policy level, let alone at other facilitating levels.

It will not be wise to leave these pockets of excellence to fend for themselves. As can be seen, in almost all areas of a desired national innovation system, India has had at least some level of experience for over a decade. Hence it will be possible to speed up the process of establishing a fully functioning system of innovation by connecting those pockets of excellence with each other and with other necessary components. The correct policies must be put in place, and the right implementation mechanisms must simultaneously be enforced. These elements need to be sustained for a long time for the laggards in the system to catch up speedily so that they are ready to innovate in products and services.

Sectoral green gardens

India has shown high growth and innovation capability in few sectors, called 'green gardens'. Two of India's fastest-growing sectors are described below.

Pharmaceutical

The Indian pharmaceutical industry plays an important role in promoting and sustaining low-cost, affordable, and innovative pharmaceutical product development in major markets.[2] Globally, India ranks third in terms of manufacturing pharmaceutical products by volume. The Indian pharmaceutical market is expected to reach more than US$ 55 billion by 2020 (Box 3).[3]

Automobiles

India has been the world's second-fastest-growing car market since 2010.[4] The Indian automotive industry has successfully introduced a range of new products in the domestic as well as the international market. The Indian auto component industry, which is dependent on the automotive industry, also has a distinct global competitive advantage in terms of cost and quality and has become the competitive supplier for the global market. It is one of the fastest-growing industries in India, with a compound annual growth rate of 23% during 2005 to 2010 and has reached US $19 billion in the year 2008–09 and is expected to grow to US$ 40 billion by 2016.[5]

Box 3: Paradigm shift in pharmaceuticals

The pharmaceutical industry has experienced a paradigm shift as a consequence of variable trends in globalization; the emergence of new markets; changing industry dynamics; and increasing regulatory, intellectual property (IP), and competitive pressures. India has become a preferred destination for R&D work because of the country's high-quality drug development, educated and skilled human resources, vertically integrated manufacturing capability, differentiated business models, and significant cost advantages.

Recently the industry has demonstrated good innovation skills in the fields of genetic research, biosimilars, vaccine development, contract research and manufacturing services, and new chemical entity development. Some instances are:

- *Innovation in biosimilars:* Biocon and Pfizer have entered into a strategic global agreement for commercialization of Biocon's biosimilar versions of Insulin and Insulin analog products: Recombinant Human Insulin, Glargine, Aspart and Lispro.[1]
- *Innovation in vaccines:* Indian biotech players are actively engaged in developing challenging vaccines. For example, India's first vaccine against H1N1 was developed by a major Ahmedabad-based pharmaceutical research company, Cadila Healthcare.[2] The Serum Institute of India has launched the indigenously developed intra-nasal H1N1 vaccine under the brand name Nasovac®.[3] Bharat Biotech has developed HNVAC, a novel vaccine that is the only developing world flu vaccine to be manufactured in a cell culture instead of eggs.[4]

Notes

1. See http://www.bloomberg.com/news/2010-10-18/biocon-sells-rights-to-insulin-to-pfizer-for-upfront-200-million-payment.html.
2. See http://www.zyduscadila.com/press/PressNote03-06-10.pdf.
3. See http://www.biospectrumasia.com/content/150710IND13091.asp.
4. See http://www.bharatbiotech.com/.

The automotive industry is also one of the largest R&D spenders within India's industrial establishment, second only to the pharmaceutical industry. R&D expenditures for domestic and multinational firms have increased considerably over the last decade. It is the domestic firms that have registered faster growth rates in absolute levels of R&D investments of Rs 2,400 crore (2010) than the multinational corporations, with Rs 210 crore for the same year.[6]

Some dry deserts

'Dry deserts' are those areas that are facing challenges in their attempts to incorporate innovation in their functioning.

Micro, small, and medium enterprises

MSMEs cover a vast segment of Indian economy with the employment of nearly 60 million Indians, distributed over 26 million enterprises. MSMEs generate a share of around 45% of the nation's manufacturing output and 40% of exports.[7]

Challenges in the input side, such as the high interest rates of 13–15% (much higher than rates for other Asian economies, which are 6–8%), rising raw materials costs, and labour costs coupled with tough competition—both in domestic and foreign markets—have added to the woes of the sector.

In terms of growth, the sector has taken a hit. As many as 91,400 micro and small units had shut down their operations as of March, 2011. The reasons cited for the closures were financial non-viability, slowing demand pull, obsolete technology, non-availability of raw material, infrastructural constraints, inadequate and delayed credit, and managerial deficiencies.[8]

The other big issue related to the sector is that about 98% of MSME units in India have very little interaction with big industries. The result is a gap in knowledge exchange between these two sectors. Almost 85–86% of MSMEs use traditional knowledge in their production units, and domestic R&D organizations have a meagre share (5–7% of the technical knowledge transactions are made with public R&D) in provisioning knowledge.[9]

The government is beginning to address the issue of the lack of financial resources for MSMEs, and it has recently authorized the Bombay Stock Exchange (BSE) and National Stock Exchange (NSE) to open a dedicated exchange for small and medium enterprises. As a policy measure, the Indian Cabinet has also approved a public procurement policy for MSMEs. Recently the Ministry of MSME has proposed its plan to increase its innovation corpus from Rs 100 crore annually to Rs 2,500 crore.[10]

Technology intensity in manufactured exports

Among all merchandise exports of countries, manufacturing constitutes the lion's share. For India this is 61.5%, compared with 93% in China, for example. In spite of India's potential strengths in technology, and with the focus shifting to newer products and newer markets as encouraged by the government's Foreign Trade Policy (2009–14), currently the average technology value-added in manufactured products by Indian industry

is around 8%—very low, even compared with that of other emerging developing nations (In 2009, Brazil's value-added share was 14%, China's was 31%, Germany's was 18%, Mexico's was 21%, and that of the United States of America was 23%).[11]

The reason behind this trend is that India focuses more on assembling and sales than on design and development, making the process very 'shallow'. Some policy reforms that are possible solutions are listed at the end of this chapter. The slow pace of building up the value-added in India's manufacturing sector has been an area of concern for a long time, and now it has to grow really quickly in order to fulfil India's dream of becoming an innovation powerhouse.

Drivers: Facilitating mechanisms and implementation experiences

Drivers for innovation in India have traditionally been weak. Be it policy, funding, infrastructure—in all areas, India has been a laggard. Since economic liberalization in the early 1990s, the government has taken some measures to improve the situation.

The primary objectives of these measures are to attract more foreign direct investment, remove licensing monopoly control, encourage growth in imports and exports, revisit the policy framework, and encourage innovation capacity within industry and society.[12] However, government purchase policies and offset mechanisms to induce private- and public-sector industries to invest in R&D design are still not in place.

Government bodies

Since its independence, India has established institutional mechanisms to address its scientific and technological development. These mechanisms include R&D labs, such as the Council of Scientific and Industrial Research (CSIR); government departments, such as the Defence Research and Development Organization (DRDO), the Indian Space Research Organization (ISRO), the Department of Science and Technology (DST), the Department of Biotechnology (DBT), and the Department of Atomic Energy (DAE); and autonomous bodies, such as the National Institute of Design (NID). These institutions have been instrumental in providing a platform for innovation to flourish. Although the DRDO, the ISRO, and the DAE have been able to create state-of-the-art technologies and innovations, the DST and the DBT have been geared more towards the facilitation of innovation (see Box 4).

For example, the Biotechnology Industry Partnership Programme of the DBT is a new scheme for promoting innovation in industry.[13] It provides government support for 50% of the total cost of a project under this scheme, leaving the remaining 50% to the industry. Out of this 50% government support, 30–50% is given to industry as grant-in-aid and the remaining is given as a loan.[14] The beneficiaries of this program are the industries whose discoveries are linked to innovations in futuristic areas, transformational technologies, and product development of public goods.

Nongovernmental organization facilitators

Different nongovernmental organization (NGO) bodies contribute towards developing industrial capability for better growth. For example, CII Centers of Excellence (CoEs) work with MSMEs at the grassroots level. One of these, the Avantha Centre for Competitiveness, has secured more than 200 successful interventions in clusters, impacting more than 2,100 companies.[15] Other niche associations—such as the Indian Machine Tools Manufacturers Association (IMTMA), the Automotive Components Manufacturers (ACMA), and the Society of Indian Automobiles Manufacturers (SIAM)—work for the betterment of their respective sectors.

Funding

Various funding mechanisms for R&D and entrepreneurship are available both within and outside the government. Government R&D labs—such as the CSIR, the Central Manufacturing and Technology Institute (CMTI), the DRDO, and around 300 others—spend a great deal of money for in-house research through various schemes and fellowship programmes. Other government bodies, such as the DST and the DBT, fund research work through grants and subsidies.

Other than government, in the last decade many Indian and multinational enterprises have developed their R&D facilities in India where cutting-edge research is taking place. Along with Indian giants such as Tatas, Birlas Mahindras, and Godrejs, global multinational corporations such as Nokia, Xerox, Bosch, Philips, GE, and IBM have invested in India for their R&D programmes.

The Department of Scientific and Industrial Research (DSIR), under the Ministry of Science & Technology, recognizes non-commercial scientific and industrial research organizations (SIROs). Under this scheme, institutions or nongovernmental bodies such as NGOs, associations, and universities that undertake scientific and/or industrial research are granted recognition for their work. Each year DSIR compiles a list of SIROs in the country (575 in its 2008

Box 4: The Department of Science and Technology: A key facilitator of innovation

Launched in the 1970s, the Department of Science & Technology (DST) has since established policies and schemes for funding, managing, and monitoring innovative initiatives across the ecosystem covering individual innovators, entrepreneurs, small and medium enterprises, and institutions. In its proposal for the 12th five-year plan (2012–17), the DST has included a major focus on innovation and proposed doubling private-sector engagement in R&D by promoting a public-private partnership model. By its own estimation, the DST will support 3 million Indians directly through its programmes over the course of the next five years (2012–17). It has identified R&D investment as a priority and suggested increasing it as a percentage of GDP from its current levels of roughly 1% to roughly 1.5% of GDP by 2017, keeping in mind the global competitiveness in science, technology, and innovation. The DST works through different functional bodies that each have defined independent goals.[1]

For example, for the past 23 years the Technology Information, Forecasting and Assessment Council (TIFAC),[2] under the DST, has been trying to address issues of innovation and commercialization through its various programmes. Three such programmes are listed below:

- The Home Grown Technology Programme (HGT). This programme aims at encouraging SMEs to carry out significant innovations at the pilot production level, thereby covering some distance towards final marketing of a product. About 59 projects were undertaken under this scheme, and approximately 38% of them reached the commercialization stage. The loans were returned. Taxes from new businesses more than offset the initial government expenditure.
- The Technopreneur Promotion Programme (TePP) is a mechanism to encourage individual innovators to become technology-based entrepreneurs ('technopreneurs') by helping them network and forge links with other constituents of the innovation chain, thus supporting the commercialization of their developments.
- The Technology Refinement & Marketing Programme (TREMAP) is designed to support the country's innovation pool by pushing innovative technologies from the prototype stage towards a viable commercial product. In the short span of two years, TREMAP has transferred five innovations / technologies to the industry of commercial use.

Notes

1. DST, 2011.
2. Detail on TIFAC is contributed by Mukesh Mathur, Scientist D, TIFAC-DST, and Sajid Mubashir, Scientist F, TIFAC-DST, Government of India.

report). SIROs contribute significantly towards the funding of R&D.[16]

The National Skill Development Corporation (NSDC) and the Global Innovation and Technology Alliance (GITA) are some of the public-private partnership mechanisms that provide funding for initiatives in skill development and bilateral or multilateral joint R&D programmes, respectively. The government anticipates establishing more models of public-private partnerships to enhance the functioning of its programmes.

Intellectual property rights

While maintaining global standards and practices and ensuring a robust IPR system, the Indian legal and administration systems have been undergoing constant modifications.[17] Indian companies protect and maintain their IP assets in India and elsewhere to their competitive advantage. For example, United Phosphorous, a leading Indian company manufacturing agro-chemicals, successfully fought a trademark infringement case in the USA and a patent infringement case in Germany. Good IP management practices followed by Indian drug companies have enabled them to gain a strong position in the generic pharmaceutical market all over the world. The IP assets of these drug companies, along with the provision of foreign direct investment in the sector, have attracted many foreign companies to look for stakes in the Indian companies.

IPR awareness in India has remained generally low; however, the central government, through its various forums, is beginning to educate people on this topic. Industries, through their confederations, associations, and federations, have also been engaged in creating awareness about the issue for over a decade now. A recent example of strong legislative enforcement for patents that is taking shape in India is compulsory licensing—invoked for the first time in 2012—to facilitate the production of a particular drug (Nexavar, a drug used to treat kidney and liver cancers) and make it available to the Indian population at an affordable price.

Design

Design is extremely important for the future of India. It is integral to national competitiveness because it contributes significantly to India's

culture, environment, and economy.[18] The government has already announced a national design policy and is implementing it through the India Design Council. The policy's priorities are to deploy design to boost exports, strengthen design education, enhance the quality of life, and increase industry competitiveness as well as to create design centres to act as innovation hubs.

The Ministry of MSME has promulgated the design clinic scheme as a part of a national manufacturing competitiveness programme to assist MSMEs to become competitive by providing partial funding support, expert advice, and cost-effective solutions to real-time design problems, resulting in continuous improvement and value addition for existing products as well as new product development. India needs many more such interventions to upgrade its design skills.

Challenges and the way forward

India, because it is a pluralistic society and a democratic country, has an inherent inertia that resists accommodating change. The political environment is far from open and transparent, and the governance system is plagued with bureaucratic hurdles. Among many other obstacles hindering innovation and growth are the poor condition of the country's urban and rural infrastructure, its very low industry-academia linkage, its low GERD, and a non-innovative MSME sector.

Far-reaching policy reforms are needed to address all these issues. The list that follows provides some guidance to the types of policy reform that, if carried out successfully, could help ameliorate some of these pressing issues.

Policy initiative 1: Increase R&D spending

The government should formulate policy with the aim of increasing total GERD to 2% of India's GDP. Policy should also assist in implementing mechanisms to encourage industry to spend 50% of its total R&D, up from its current level of 20%.

India's national innovation infrastructure should be revisited, and reforms need to be incorporated to improve governance and make it more transparent (through the use of e-governance) and to upgrade infrastructure with projects to develop roads, energy distribution, water availability, for example.

Policy initiative 2: Global partnerships in innovation

Global innovation partnerships need to be strengthened. Policy can address this need by enhancing public-private partnership mechanisms such as GITA, and increased public funds should be earmarked for joint industrial R&D projects that include more countries and larger projects.

Policy initiative 3: Offset production

Policy may also be effective in extending the concept of offset production in India, not merely for defence purchases—where India's offset policy requires foreign suppliers to carry out some production in India or some R&D in collaboration with Indian firms—but also for other major sectors such as energy infrastructure, transport, and other broad sectors.[19] It is important, however, to avoid making these policies too rigid and unapproachable. Foreign investment, especially in MSMEs, that is undertaken to upgrade the capacity of the enterprise to take on such offset production responsibilities may also be counted as offset fulfilment. The aim of such foreign direct investment is to bring some focused, continual 'irrigation' of innovative capacity to a vast sector that was previously a dry desert in terms of innovation.

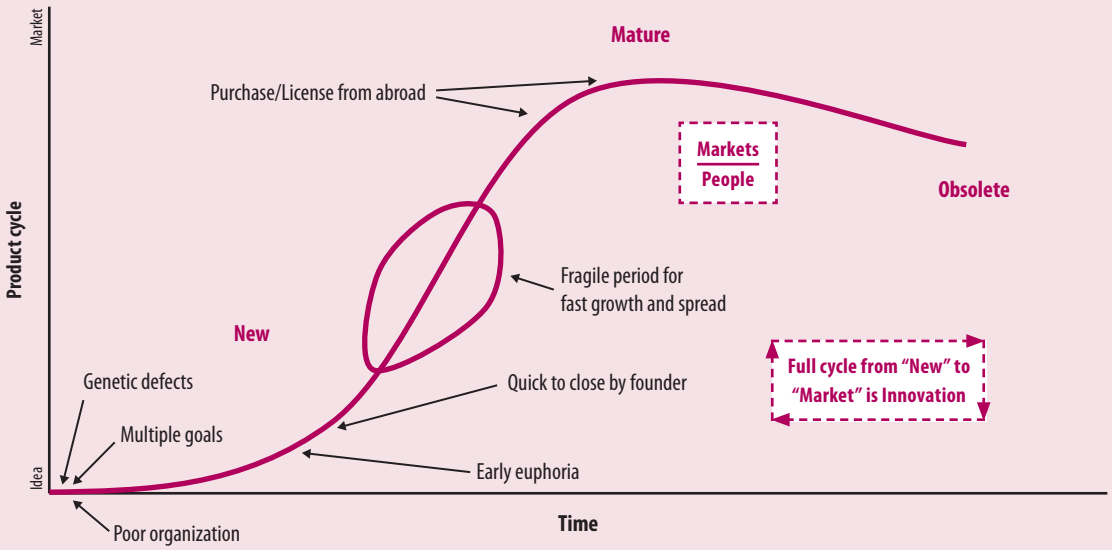
Policy initiative 4: Idea-to-market challenge

When considering the movement of ideas towards markets in India (see Figure 1), several problems at the idea stage itself become evident: the understanding of user needs and market needs, as well as the costs of bringing an idea to market, is generally poor. Other elements important to success, such as knowledge about competitors, are also lacking. In addition, most projects tend to be poorly organized, and multiple goals (often contradictory) are frequently assigned to a single project, leading to confusion. In spite of these hindrances, some innovative projects—especially those that begin in national labs or academic institutions—are launched with good results, leading to an early euphoria on the part of the innovator and other project stakeholders and sometimes media (if the innovation is large).

These euphoric early successes give way either to technology transfer or sell-offs, when the innovator sells off the enterprise/idea rather than making the effort to grow the venture. Even government funding schemes do not encourage further efforts to scale up initiatives that are successful in their early stages. For these projects, 'science' or R&D has been completed, and they are conveniently left to the mercy of users and industry. Venture capitalists who join the project at this stage often expect a quick return and tend to leave immediately thereafter, not remaining to support further R&D.

This period, in which everybody forgets the idea and the work and starts assuming that success has been achieved, is called the 'fragile

Figure 1: Idea-to-market curve



ellipse'.[20] The consequence is fewer idea-to-market innovations originating from India. Those who dare to enter markets with their innovative technology and desire to meet a user demand and make a successful business are usually forced to look abroad for licensing their technology, (although they may not be the best fit for India), in absence of a well-established Indian procurement system. These entrepreneurs will often be near the mature stage of the innovative solution and thus close to being obsolete in business, practically surviving at the top of curve, with only marginal shallow innovations in marketing and pricing.

To address these challenges the government needs to create a special fund to help Indian innovations, wherever they originate—in public or private sectors of industry, laboratories, or individuals—to advance beyond the fragile ellipse. Such a fund will require a special, flexible system of management. As a step in this direction, the government's National Innovation Council plans to establish the India Inclusive Innovation fund with US$1 billion.

Path forward

In spite of all the drawbacks, weaknesses, and challenges facing India's innovation system, India is presented with an opportunity to become a global innovation hub and eventually transform itself into an innovation-driven economy using its existing resources. To be successful in this endeavour, the country must make the right institutional, industrial, and policy reforms.

Notes

1 Arun Maira is a member of the Planning Commission of the Government of India, a member of the National Innovation Council, and a strong advocate for innovation in the Indian economy.

2 Details on pharmaceuticals were contributed by Dr. Goutam Muhuri, President, R&D – Dosage Forms, Jubilant Life Sciences.

3 See http://www.pharmaceutical-drug-manufacturers.com/pharmaceutical-industry/.

4 The Times of India, 2011.

5 IBEF, 2010.

6 See the Centre for Monitoring Indian Economy (CMIE), Prowess Dataset. One crore is 10 million.

7 Government of India, *MSME Annual Report 2011–12*, available at http://msme.gov.in/MSME-Annual-Report-2011-12-English.pdf.

8 Business Standard, 2011.

9 NISTADS, 2009 http://www.nistads.res.in

10 Bhatia, 2012.

11 Department of Commerce, 2011.

12 Ray and Saha, 2010.

13 See the Department of Biotechnology website at http://dbtindia.nic.in/uniquepage.asp?id_pk=680.

14 DBT, 2010.

15 CII & MSMEs an update; see http://www.ciicfc.org/abtus.html.

16 DSIR, 2008.

17 Details on the IPR system are contributed by R. Saha, Senior Advisor, Confederation of Indian Industry.

18 This perspective on design is contributed by Hrridaysh Deshpande, Director, DY Patil & Dilip Chhabria; see http://www.dypdc.com/directorspeaks.php?pageid=5.

19 'Offset' is a trade-off in a formal arrangement where a foreign supplier undertakes specified programs with a view to compensate or assist the buyer in its procurement expenditure and generate benefits for the economy of the buyer's country.

20 The author, Y. S. Rajan, got this description of the ellipse from Prof. S Chandrasekhar of IIM, Bangalore, based on his extensive research on innovation ecosystems in India. Rajan would like this phenomenon to be known as the 'Chandra-Ellipse of IIS fragility'.

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Acronyms

ACMA	Automotive Components Manufacturers
APTDC	Andhra Pradesh Technology Development and Promotion Centre
BIS	Bureau of Indian Standards
CII COE'S	Confederation of Indian Industry, Centres of Excellence
CMTI	Central Manufacturing and Technology Institute
CPRI	Central Power Research Institute
CSIR	Council of Scientific and Industrial Research
DAE	Department of Atomic Energy
DBT	Department of Biotechnology
DIPP	Department of Industrial Policy and Promotion
DRDO	Defence Research and Development Organization
DSIR	Department of Scientific & Industrial Research
DST	Department of Science & Technology
GITA	Global Innovation and Technology Alliance
ICAR	Indian Council of Agricultural Research
IISC	Indian Institute of Science
IIT	Indian Institute of Technology
IMTMA	Indian Machine Tools Manufacturers Association
IPO	Indian Patent Office
IPR	Intellectual Property Rights
ISRO	Indian Space Research Organization
MSME	Micro Small and Medium Enterprises
NABARD	National Bank of Agriculture and Rural Development
NID	National Institute of Design
NISTADS	National Institute of Science, Technology And Development Studies
NIT	National Institute of Technology
NSDC	National Skill Development Corporation
NSTEDB	National Science & Technology Entrepreneurship Development Board
RDSO	Research Design and Standards Organization
SIDBI	Small Industries Development Bank of India
SIRO's	Scientific and Industrial Research Organization
TDB	Technology Development Board
TIFAC	Technology Information, Forecasting and Assessment Council
TNTDPC	Tamil Nadu Technology Development and Promotion Centre
TT Units	Technology Transfer Units