ROLE OF INNOVATION IN ACHIEVING TECHNOLOGY AND BUSINESS COMPETITIVENESS

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Summary

Innovation is increasingly being recognized as the key to technology and business competitiveness. This paper explores the anatomy of Innovation, and attempts to identify the key success factors promoting Innovation, as also barriers and impediments to Innovation. The nexus between Innovation and Entrepreneurship is explored, and the desirable characteristics of Innovators and Entrepreneurs are highlighted. Particularly for our country, the Technology Denial Regimes must act as motivation for promoting Innovation. A number of Case Studies drawn from across the globe provide valuable lessons for promoting and sustaining Innovation in the national Education and R&D systems. The barriers to Innovation are examined, with particular reference to our country.

1. The Anatomy of Innovation

Innovation stands for new products, information, knowledge and services. It stands for Renewal; recreating oneself. It requires Imagination and Insight. It is more than just invention and marketing; it should extend the realm of possibilities of the organization and its people. It implies "thinking beyond traditional boundaries ". One creative artist explained: "Creativity is in that which I do, and not in me ". There is also no proven scientific theory about Creativity or Innovation.

Creativity is far more than a grandiose flash of inspiration. It is a process, a discipline, an ability which goes beyond simple improvements. Creativity has a sisterly bond with curiosity. The following two quotations capture the essence of Innovation:

- "The old is always yesterday's innovation. Innovation is tomorrow's redundancy".
- "The future can best be predicted by inventing it" – Alan Kay, Xerox Palo Alto Research Centre, the legendary Power House of ideas in California.

Table I provides a summary of major differences between Creativity and Innovation; which are often employed synonymously.

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It is frequently observed that the same creative individuals will be more creative in certain environments than

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TABLE - I

Some Differences Between Creativity and Innovation

CREATIVITY	INNOVATION
◆ Dictionary definition :The ability to produce new and original ideas and things; imagination and inventiveness.	◆ A new idea, method or invention; the introduction of new things.
◆ Intrinsic to all humans and can be 'triggered off' in a variety of ways.	◆ Requires specific conditions to be created in companies where strategic, organisational issues are creatively resolved through the involvement of people.
◆ Individual creativity associated with flashes of insight.	◆ Requires a focussed search for the resolution of clearly identified issues.

others. A case in point is that three of 'our' recent Noble Prize Winners, Chandrasekhar, Khurana and Amartya Sen were awarded the coveted honour *in recognition of work done abroad, not* in India. Our high-quality manpower which prefers to go abroad to pursue their professional careers, characterized as Brain Drain, cite the lack of a challenging and fair work environment as the principal 'push factor' for their decisions. It is pointed out that the demanding environments abroad provide:

- a strong focus
- a general awareness of new ideas
- an open atmosphere for discussion, and
- a healthy balance between individual competition and social *cooperation*

Kito de Boer believes that Innovation per se is not a 'good thing'. The only universally 'good thing' is performance. Good Innovation must be both new and also create wealth. Newness can come from 3 sources – *preferably in combination*;

- New to the consumer
- New to the producer
- New to the channel.

According to him, Innovations incorporate new *Insights* about the consumer, new *Technologies* that reinforce the producer's competitive capability, and new *Business Processes* to improve the ability of the corporation to deliver value. Depending upon the amount of newness and wealth generated, he provides a taxonomy of innovation:

◆ ***Incremental Innovation***: creates products; it is the basic price of survival in most markets. Individually small, they are collectively important. An example is a new improved

version of Rin detergent with an improved optical brightness.

- ***Step change Innovation:*** creates businesses ; it is the major engine of growth, and can create significant shifts in competitive advantage. An example is the entry of Nirma, which incorporated new insights about consumers, in addition to new business processes to deliver large volumes at lower cost. Titan watches is another example, combining new quartz technology and new business processes, creating the Titan shop.

- ***Transformational Innovation:*** Creates industries ; corporations can capitalize on market transformation by riding the wave of change. An example is the emergence of powerful and efficient retailers, which has transformed the consumer industry for big companies like P & G and Unilever. It is also expected that the emergence of electronic shopping on the internet will transform retailing in the future.

2. Elements of the "Environment" Impacting on Innovation

In his Presidential Address to the 2005 Annual Meeting of The National Academy of Engineering (USA) recently, Professor William Wulf has pointed out that "the phenomenal transformation of our quality of life has been fuelled by innovations created by engineers, and the pace of innovation, if anything, is accelerating". In fact, the NAE (USA) has compiled a list of the 20 greatest engineering achievements of the twentieth century.

While there is a widespread consensus that innovation is crucial for prosperity and competitiveness, Wulf asserts that there is no simple formula for innovation. However, a "multi-component environment "appears to collectively encourage or discourage innovation. He lists the following as some of the essential components of this environment:

- a vibrant research base
- an educated workforce
- a culture that permits, even encourages, risk-taking
- a social climate that attracts the best and brightest from anywhere in the world to practise engineering
- "patient capital" available to the entrepreneur
- tax laws that reward investment
- appropriate protection for intellectual property; and
- laws and regulations that protect the public while encouraging experimentation

3. The Nexus Between Innovation and Entrepreneurship

Radcliffe has described the inter-relationship of innovation and entrepreneurship. He distinguishes between creativity as "finding, thinking up and making new things (knowledge for its own sake)", and innovation as "doing and using new things (creation of new wealth)" and describes

entrepreneurs as "catalysts for change by converting opportunities into marketable realities". He quotes IPENZ that "innovation is the art of creating something new and worthwhile, entrepreneurship is the art of carrying an innovation to market in a commercial manner". Innovation is often about "taking an idea that is obvious in one context and applying it in a not so obvious way in a different context".

The 3M Company defines innovation as "new ideas plus action or implementation which results in an improvement, gain or profit". It identifies three types of innovation:

- New market or industry
- Changing basis of competition
- Line extension

In line with the blurring of innovation and entrepreneurship in its definition, 3M has adopted the word "inventorpreneur" to describe its outstanding innovators. They invent or create a new product that fulfils a defined need; promote the new opportunity or product; manage, organise and assume many risks in establishing a new business based on that product".

It is also pointed out that innovation is more about creating environments that foster innovation than about brilliant individuals. An "innovative environment" has been characterized as one that:

- Is trusting
- Is open to new ideas and alternative approaches to solving problems and exploiting.
- Operates in an environment of flexibility
- Is goal-directed with a sense of purpose, and
- Demonstrates that innovation is valued and recognises innovative achievements.

4. Desirable Characteristics of Innovators and Entrepreneurs

On the basis of a case study of the managers of a design consultancy specializing in product and process innovations, Steiner has suggested that innovators should be:

- Energetic
- Enthusiastic
- Competitive
- Innovative
- Thrive on change, diversity and challenge, and
- Be able to live with uncertainty

"They must be competent, credible and effective in their area of professional expertise, but be able to blend these technical skills with business acumen. They require excellent people skills, including communication and managerial skills. In addition to these *skills* and *qualities*, they also require a set of *attitudes* that action the skills." These comprise:

- "a challenge-seeking attitude
- being a genuine team-player while also being self-directed and autonomous
- responding positively to external

pressures, not retreating from them

- a desire to keep learning (and not imagining they know it all)
- be interested in the commercial aspects
- show 'intellectual flexibility', and
- be able to keep striving but to also accept defeat".

The 3M company looks for people with specific traits as indicators of their potential to be innovators:

- creative
- broad interests
- problem-solver
- self-motivated/energized
- strong work ethic
- resourceful

It is interesting that the underlying factors responsible for success as innovators and entrepreneurs have been known for some time, and have not changed in spite of significant changes which have taken place in technology, business and society. As may be expected, the characteristics of the innovator and the entrepreneur overlap.

Williams "describes entrepreneurs as people who have both the will (e.g. desire or motivation) and skill (e.g. the ability) to project an idea or scheme into the future by backing their judgement with innovative action and persistence in order to turn that idea into reality."

He also points out that they tend to be:

- Creative individuals with a never-ending supply of ideas and schemes.
- Action people who make things happen
- Catalysts (initiators of change)
- Aggressively ambitious and highly competitive
- Moderate risk-takers (not risk-averse but not gamblers)
- Self-reliant and independent
- Resourceful and shrewd
- Highly tolerant of ambiguity and uncertainty
- Determined, optimistic and persistent; and
- Very future-oriented.

Radcliffe points out that innovation is not determined solely by the skills and attitudes of individuals or even teams. Performance also is dependent upon the tasks being undertaken and the work environment. Williams asserts that "entrepreneurship is what entrepreneurs do rather than a list of personality traits." "Innovation and entrepreneurship are contextual, enacted and holistic activities", and consequently, "attempts to extract their elemental parts via a reductionist paradigm for inclusion in a curriculum are likely to fail."

5. Technology Denial Regimes as Motivation for Promoting Innovation

Bijlani has clearly brought out the necessity for India to undertake and promote Innovation in Technology Development in the current and

emerging scenario of Technology Denial Regimes, WTO imperatives, etc. It is increasingly being realized that it is technology, not tariffs, which will keep competition at buy. Technology transfer has long been relied upon in our country for acquisition of advanced technology. It belies a lack of understanding of what technology is all about, and what the emerging imperatives are.

Most of what has been acquired as technology through technology transfer agreements is in the nature of acquisition of drawings and process know-how for manufacture of goods. It did not include the knowledge of materials, procedures for product development, specifications and standards. Bijlani points out that Technology, in the final analysis, is the ability to develop, to make things we have not seen before, the ability to systematically develop new products, keeping in mind their life cycles.

Some of the technology denial regimes which are closing in around us, and which will make it difficult, if not impossible, for us to procure technology, are :

- EU policy on export of 'dual-use' equipment, materials and technology
- The erstwhile COCOM, which coordinated multilateral export control regime during the cold war against the Eastern Bloc countries in Europe, is now being given sharper teeth.
- European controls for items such as AC servomotors, pre-loaded ball screws, limit switches and bearings, which have already affected Indian machine tool manufacturers.
- The Dual-use and Related Goods Regime introduced by the UK in 1995.
- Japan has created a new database to cover information on 'suspect buyers' of technology.
- Germany has banned export of 'sensitive items'.

It is thus seen that denial of technology is not confined to military goods. The TDR is expected to cover more technologies and products in the coming years. Bijlani points out that "Purchasable Technology is out of date and Contemporary Technology is not purchasable", and calls for a "new urgency to technology development by Indian Industry".

6. Peter Drucker's New Rules for R & D

Peter Drucker , who has been quite successful in advising the corporate sector to successful performance and in defining the future course of management paradigms, has proposed some new rules for R&D. He proclaims that R&D should be business-driven, not technology-driven. According to him, the starting points of the new R&D paradigm are the business goals and strategy of the firm ; for example, RCA color TV, and Sony VCRs, fax machines and copiers. First-rate R&D labs need to be set up as free-standing businesses. The R&D function would be better managed by a 'Technology Manager' than a "Research Director'.

Every new product, process and service begins to become obsolete from the time it breaks even. In the

context of result-based approach to R&D, any distinction between 'Pure' and 'Applied' research is meaningless. In effective research, Physics, Chemistry, Biology, Maths., Economics, etc. are not 'disciplines' with determinate boundaries ; they are tools and resources for creative use towards accomplishing performance objectives.

R&D work comprises three different but complementary dimensions of effort : Improvement, Managed evolution, and Innovation. R&D efforts should aim high to make a real difference in the customer's life or business. Effective R&D requires both long-range and short-range results. Effective R&D requires 'organized abandonment' of products, processes, services and research projects, when :

- There are no more significant improvements
- New products, processes, markets or applications no longer come out of managed evolution
- Long years of research fail to produce commercially useful results.

7. Innovation Promotion Initiatives in the Academe

7.1 Foundation for Innovation and Technology Transfer (FITT) at IIT Delhi:

It was established as a Registered Society in 1992, with the mission: "To be an effective interface with the industry ; and to foster, promote and sustain commercialisation of S&T in the Institute for mutual benefits".

Among the key terms of reference are: to add commercial value to academic knowledge and to market the intellectual and infrastructure resources of IIT Delhi for national development".

7.2 Society for Innovation and Development (SID) at the Indian Institute of Science:

It was founded in 1999 with the mission: "to enable India's innovations in S&T by creating a purposeful and effective channel to help and assist industries and business establishments to compete and prosper in the face of global competition, turbulent market conditions and fast-moving technologies". It has a symbiotic relationship with IISc in an industry-friendly as well as a faculty-friendly way.

8. The Boston Bank Study of MIT : The Impact of Innovations

This Report examined the role of Innovation and the economic impact of a Research University. It was pointed out that MIT - related Companies are not typical of the economy as a whole; they tend to be knowledge-based and in hi-tech. fields, such as software, electronics, and biotech. The Report has identified some reasons for MIT's success:

- Combination of an Engineering School that attracts bright students interested in cutting edge S&T, and a Management School that helps create the appropriate environment.
- Marriage of Technology and Management.

- Unique environment conducive to producing risk-taking entrepreneurs.
- Formal and informal activities that promote "entrepreneurism". For example, Entrepreneurs' club; Centre for "Entrepreneurism"; 50K contest; Enterprise Forum – supported by Alumni
- "The Institute's ethos is even more important than formal programs in stimulating hi-tech entrepreneurs".

9. Case Studies

The following Case Studies, drawn from different countries, illustrate the different strategies adopted for promoting and sustaining innovation in technology and business.

9.1 CaseStudy

I. Growing ontario's Innovation System : The Strategic Role of University Research

Heather Munroe-Blum, with James Duderstadt and Sir Graeme Davies, completed a Study in Dec. 1999 for advising the Ontario Government on strategies to be adopted to improve the global competitiveness. It was pointed out that "*Productivity and Innovation* are the strongest determinants of standard of living in the knowledge-based society, and provide the only direct route to recession-proofing the economy, and achieving broad economic and social benefits". *Research performance* is a robust predictor of productivity and innovation. Innovation involves *leaders* – talented, educated people, with a variety of experiences and skills. Innovation draws on the full range of: sciences; humanities and social sciences; basic and applied research; and on technology; judgement; action; timing; and investment.

In the global knowledge society, the Report emphasized that *speed* wins. *Talent* was identified to be the primary strategic resource for innovation. "Talented people and knowledge are at the heart of innovation, sustainable growth of good jobs, and the health of nations". Universities and university research are the chief suppliers of a nation's knowledge, knowledge workforce, and innovative technologies. This is particularly important because talented people and knowledge are fast replacing financial and physical capital as the means to achieving prosperity and economic security.

The following recommendations were made:

- Create an optimal university research policy environment for innovation.
- Grow talent and university research competitiveness, and construct a world-class infrastructure.
- Expand the impact of university research and foster entrepreneurship.
- Foster local, national and global innovation networks and global profile.
- Celebrate our people, achievements and success.

It was proposed that "Innovation will be advanced by a strategic university

research policy reflecting principles of: Academic/scientific autonomy, Competition, Disciplinary inclusion, Excellence, Distinctiveness, Vision, Teaching-Research synergies, Service Impact, and Means of recognizing, rewarding and celebrating talent and achievement. Private sector investment should not displace sustained public investment in university research, but rather serve to grow the broad platform of investment in research; implementation and administration of university research policy and programs must be simple and responsive; proliferation of regulation and bureaucracy paralyze innovation. Attracting and retaining superb graduate students is essential to growing the next generation of talent".

The ratio of Gross Expenditure on R&D (GERD) to total GDP : (GERD/ GDP) is one of the most robust indicators of an economy's innovation and research. A 1999 OECD study benchmarking knowledge-based economies revealed the following (for 1997):

- Research of OECD countries averaged: 2.2%
- Sweden : 4%
- Finland, Japan, Korea, US : 3%
- Canada : 1.6%

9.2 Case Study - II:

U. K. The Innovation Report : "Competing in the Global Economy : The Innovation Challenge" (17 Dec. 2003)

This Report looks at the contribution that Innovation can make for driving productivity and to achieving the vision of the UK as a key knowledge hub in the global economy. The contents of this Report are:

- Chapter 1: The innovation challenge
- Chapter 2: High-performance innovation companies
- Chapter 3: Technology Innovation
- Chapter 4: National innovation assets
- Chapter 5: Innovation policies across Government
- Chapter 6: Regional innovation
- Chapter 7: Global links

It is pointed out that Innovation matters because it can deliver:

- ❖ high value-added products and services;
- ❖ new, cleaner and more efficient production processes; and
- ❖ improved business models.

The information is organised under six key themes:

1. ***Knowledge Transfer :*** between business and the science base, from business to business, and in collaboration with international partners.
2. ***Innovation in Procurement*** : using Government's enormous purchasing power to stimulate innovation
3. ***Skills and Workplace :***

Supporting high-level skills and high-performance workplaces

4. ***Regional Innovation***

5. ***Regulatory Framework :*** IPR, standards and regulations that support innovation

6. ***Small Businesses :*** Supporting entrepreneurship and small businesses as key sources of innovation.

9.3 Case Study

III : 2005 Value -Added Scoreboard - The Top 800 UK & 600 European Companies by Value Added Dept. of Trade & Industry (DTI) - UK

Value Added is defined as the wealth created by activities of a company and is specifically designed for the scoreboard as sales less the cost of bought-in goods and services. It can be calculated from a company's audited annual accounts. US and Japanese companies do not disclose enough information in their accounts to enable value- added to be calculated. The Scoreboard is intended for 3 main audiences:

- companies – for benchmarking
- investors – to provide perspective on a company performance
- policy makers in business, sectoral and government organisations.

9.4 Case Study - IV R & D Scoreboard 2004 - U.K.

In his Ministerial Foreword — Lord Sainsbury, Under Secretary of State for Science and Innovation, points out that Innovation is at the heart of productivity growth, and R&D is one of the key drivers of innovation. The R&D Scoreboard highlights the relative strength of the UK economy in some R&D-intensive sectors such as: pharmaceuticals & biotechnology, aerospace & defence, and health, where both the UK's proportion and intensity of R&D are at or above international levels.

What the R&D scoreboard contains: Details of R&D investment; Capex; Sales; Profits; Employee numbers; Growth of these quantities; Key ratios; and Market capitalisations for UK and international companies. All data are extracted directly from company annual reports & accounts; and key ratios are calculated for each company and sector. Companies are classified by FTSE sector and by country.

What the Scoreboard doesn't say : That the R&D reported in company's annual accounts is the only measure of innovation. Other methods of gaining competitive advantage include: investments in capital equipment; market development; skills; new ways of working; new business processes; other intangible assets; and linkages with other organisations.

9.5 Case Study - V : Germany's Technological Performance report to BMBF, 1997

It was pointed out that the prospects for the Future were good because of the foundation provided by Five factors :

- Highly skilled labour force, particularly in fields that are key to Innovation in the

Technological and Organizational areas.

- Productive, high-powered R&D facilities that produce marketable S&T findings.
- Broad store of know-how in firms.
- intensive application of know-how in Industry, and integration of generic technologies into the broad industrial spectrum.
- Industry's highly developed ability to translate know-how into technological innovations, products for global markets, and top-quality services and processes.

In the matter of R&D and Innovation Systems, it was pointed out that decoupling R&D efforts and successful innovation would only work for a short time. A good business outlook is a vital pre-requisite for expanding R&D capabilities. Internationalisation of R&D was progressing rapidly in research-intensive industries, such as Telecommunication and Semiconductor Products. It was also shown that Innovation has a selective impact on the job market. Employment among the highly qualified was rising, whereas unskilled labour was experiencing a worsening situation. This trend was found also in the Service sector, which is looked upon as the magic remedy for alleviating unemployment problems.

This was also the case in the US, where even a booming job market could not close the growing gap between rich and poor. Innovation leads to job cuts because it raises productivity levels. On the other hand, without innovation, international competition would be a direct threat to unproductive jobs. Hence, there is no alternative to innovation-oriented policies.

Germany's national innovation system is described as "a model of cooperative consensus". It does not produce as many "radical innovations"as in the US, where new technologies have only loose ties to prevailing industrial structures. In Germany, innovation develops primarily on an "incremental" basis, as the result of close cooperation between Science, Research and Industry. Innovators in Germany are similar to a centipede:"They move forward slowly - but systematically and surely - on their many legs".

10. Barriers to Innovation with Special Reference to our Country

10.1 Country - Specific Barriers

- Lack of consistent and sustained policy support
- Lack of sincerity of purpose and transparency
- Tradition of rote learning
- Technology is alien to the majority of the population
- Ideological hang-ups
- Gap between public announcements and practices
- Lack of entrepreneur – friendly ambience
- Too much reliance on routine jobs.

10.2 Education - Specific Barriers

- Too much regimentation and rote learning
- System aimed more at solving social equity problems than at nurturing merit
- No specific efforts to promote Creativity and Innovation
- Acute scarcity of motivated, committed and trained teachers.

10.3 Industry - Specific Barriers

- Lack of self-confidence – in Indian academic and industry capabilities.
- Product volumes too small to afford investments in innovation-promoting activities
- Industry is largely oriented to domestic markets and not to export markets.
- While India has a large body of educated and trained manpower, the extra bit required to create innovation products is lacking.
- Indian Industry is pre-occupied with problems of infrastructure, raw materials, cash flow, procedures, bureaucracy, politics.

11.The Innovator's Dilemma Clayton M. Christensen, 1997

Clayton Christensen, in his insightful book, postulates that the logical, competent decisions of management that are critical to the success of their companies are also the reasons why they lose their positions of leadership. "Good" companies often begin their descent into failure by aggressively investing in the products and services that their most profitable customers want. An organization's historical choices about which technological problems it would solve and which it would avoid, determine the sorts of skills and knowledge it accumulates. Firms fail when a technological change destroys the value of competencies previously cultivated, and succeeds when new technologies enhance them.

When disruptive innovations – which are typically cheaper, simpler-to-use versions of existing products that target low-end or entirely new customers – emerge, established companies are paralyzed. He calls this phenomenon "asymmetric motivation". He identifies it as the core of the "innovator's dilemma", and suggests that it is also the beginning of the "innovator's solution".

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