Sixth Title in the Series of Books on World Class Universities or Institutes

innovation

Growth Engine for Nation

Nice Buzzword but Often Misunderstood

Compiled By
Dr. Rajiv V. Dharaskar

In most simplified way, this book explains the Inner Dynamics of the concept of Innovation from A to Z.

In USA, Innovation supports at least 40 million jobs and contribute 34.8 % US GDP. South Korea, the Top most Innovative country of the World could raise GDP (PPP) per capita to $33140. India is just at $5410 (123rd position in the world). Innovation is must for economic growth & to become developed nation. But in the Innovation Decade (2011-2020), India slipped 10 ranks (76th position) in Global Innovation Index 2014. How to improve this situation? How to introduce the culture of Innovation in India? What are the root causes of poor Innovation Ecosystem in India? What is the importance of Innovation Clusters? What are the best practices all over the world? How to introduce innovation in industry and R&D labs? How to introduce innovation in Academia? How to enhance employability through Innovation Competencies? I would like to answer these question with the help of hundreds of interesting case studies.

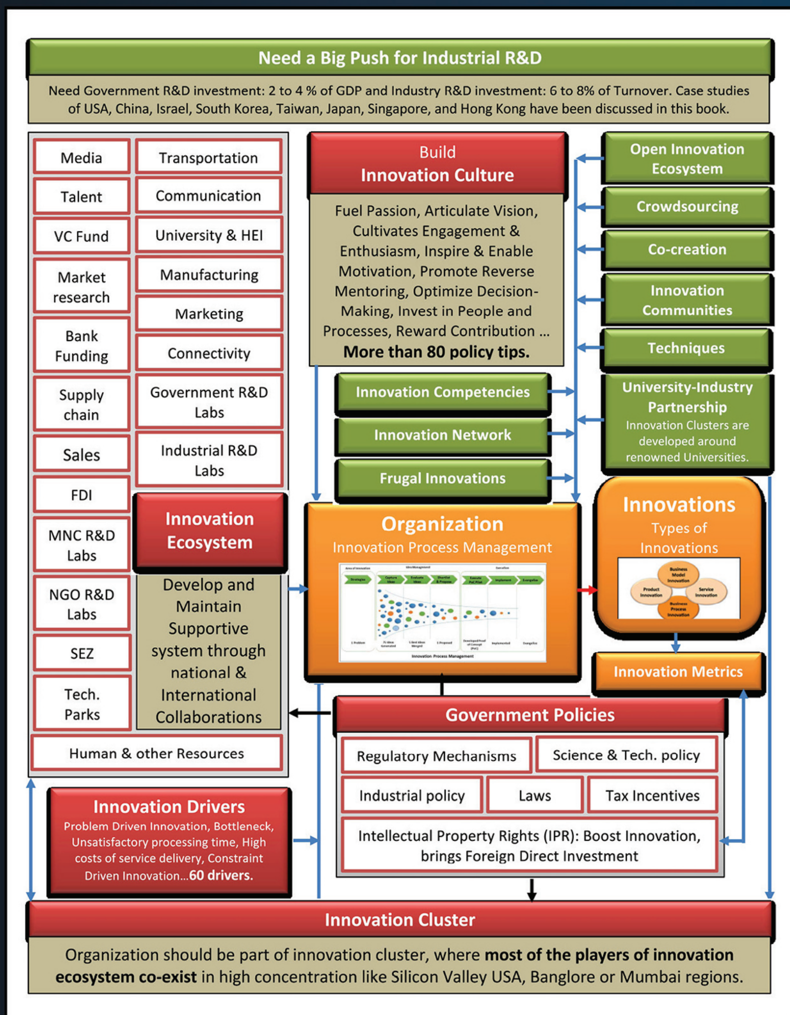
I would like to ignite human brain for innovation through this venture. I am sure once you read few pages of this book, you will be in love with this book. It's for everybody; from industry to academia; from government authorities to office staff; from parents to students; from faculty of medicine or engineering to faculty of Arts; from small scale businessman to corporate house. I have written this book in such way that everybody should be benefited and start thinking creatively. Before my final departure from this world, I would like to see our nation as Developed Nation. It can happen only through Innovation.

I am sure, after "Skill India" and "Make in India" the next slogan will be **"Innovation India".**

SPD®

Innovation - Growth Engine for Nation - Nice Buzzword but Often Misunderstood

This book covers almost every essential concepts related to Innovation along with hundreds of interesting case studies.



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Ph.D. (Computer Engineering)

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Dedicated To

Dignitaries who are taking keen interest in the field of Innovation in India	
Hon. Pranab Mukherjee President of India	
Hon. Narendra Modi Prime Minister of India	
Dr. Raghunath Mashelkar Former Director General, CSIR	
Dr. Rishikesha Krishnan Director of IIM Indore	
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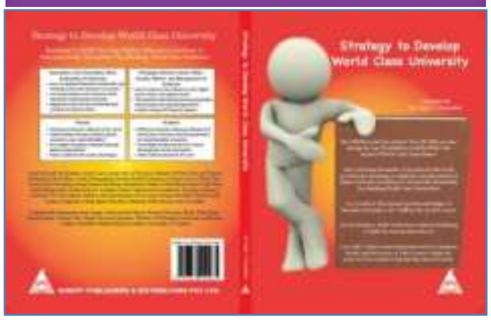
Published Books: World Class University Series

1

Funding Techniques of World Renowned Universities
(204 pages, 251 References)
Date of Release: 15 Feb 2013

2



Strategy to Develop World Class University
(500 pages, 444 References)
Date of Release: 15 Feb 2013
Date of Release: 15 Aug 2013

3

Technology-Storms Redefining World Class Universities
(412 pages, 523 References)
Date of Release: 15 Oct 2013

4

113 Difficulties in Developing World Class Universities
(319 pages, 345 References)
Date of Release: 20 March 2014

This book is available for FREE download at
http://dharaskar.com/world-class-university-book-4.html

5

Washington Accord & Multi-Objective Integrated Model for Developing WCU
(328 pages, 417 References)
Date of Release: 15 Aug 2014

This book is available for FREE download at
http://dharaskar.com/world-class-university-book-5.html

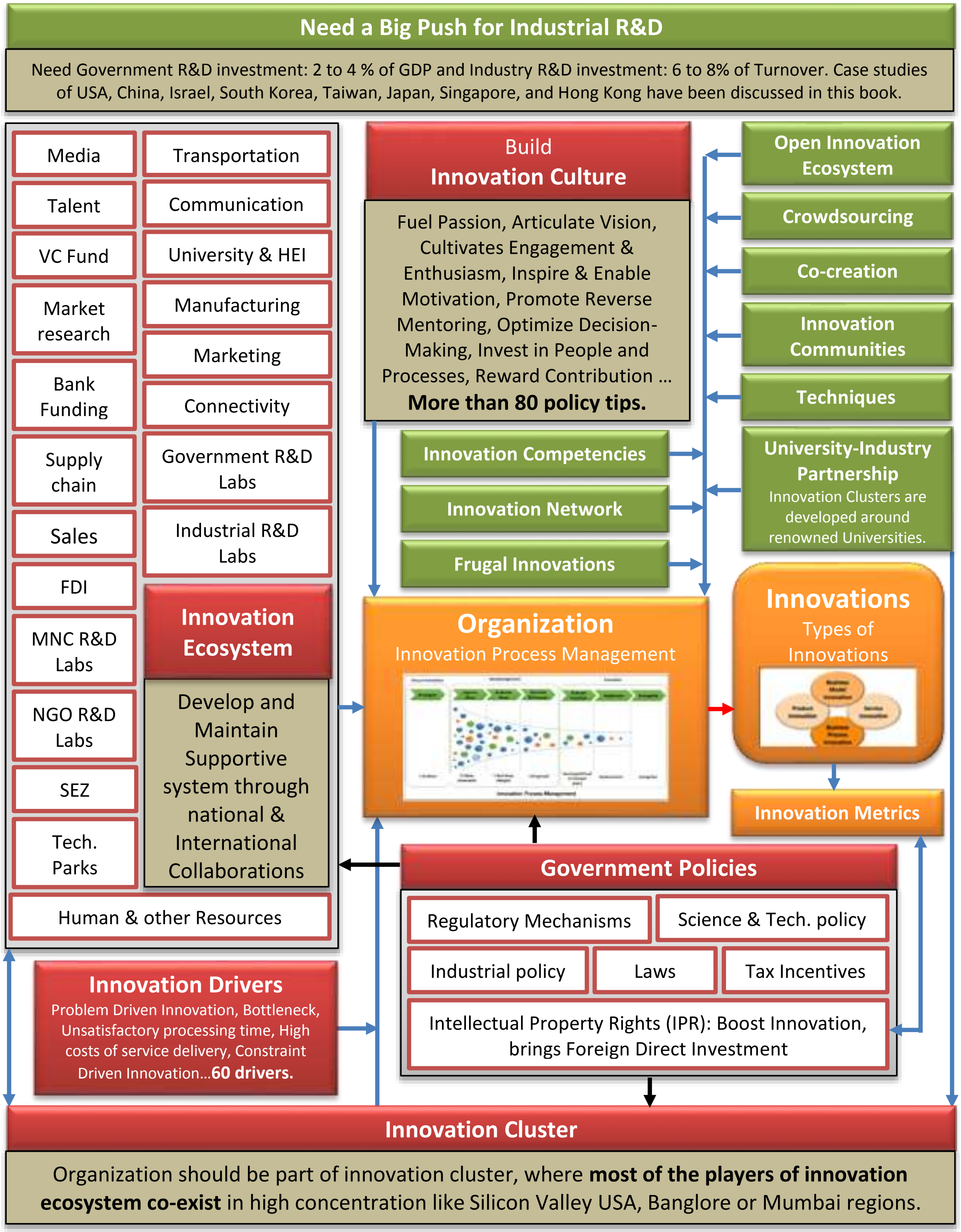
Preface

On one side, the world is appreciating India's spectacular growth in Space, Nuclear and Missile Technologies and many more fields. On other side, India slipped 10 ranks (76th position) in Global Innovation Index 2014. The Innovation is the Growth Engine for the Nation. The rate of Innovation depends upon National Innovation Ecosystem. Thus Innovation Ecosystem decides the rate of growth of economy of the nation. It is way to become developed nation. The nation can't afford to neglect this vital issue.

What is wrong with system? What is the reality? Where is the actual problem? We need to analyze **the Bigger Picture** "The Innovation Ecosystem", in which the University is just one of the players. In the series of 5 books on World Class Universities, I could focus only on one player but that is not sufficient to enhance the entire economy of the nation. In fact, the World Class University (WCU) Model must be tuned according to Innovation Ecosystem of the Nation. The **Bigger Picture** decides the role of each player with respect to the national framework. If we understand this phenomenon then it is very easy to find out root causes and remedies of many national issues. This is the reason, I have included this book in the series of books on world class universities. But remember that, here focus is not simply on university. I would like to cover **Bigger Picture**, which is based on concept of Innovation.

In most simplified way, this book explains the Inner Dynamics of the concept of Innovation from A to Z. I would like to answer many vital questions like: How to improve this situation? How to introduce the culture of Innovation in India? What are the root causes of poor Innovation Ecosystem in India? What is the importance of Innovation Clusters? What are the best practices all over the world? How to introduce innovation in industry and R&D labs? How to introduce innovation in Academia? How to enhance employability through Innovation Competencies? I have quoted hundreds of carefully selected small case studies to justify the stand.

India has many islands of excellence, Plenty of Innovative Brains but Lack of Well Developed and Organized Innovation Ecosystem. The Innovation Ecosystem is a complex phenomenon and contains dozens of players like Universities, Higher Education Institutes, National R&D Labs, Industrial R&D Labs, Multi National company's R&D Labs, Intellectual Property Rights (IPR) Culture, Venture Capital Funding Organizations, and many more. To nurture the Innovation requires Innovation Ecosystem, Innovation Clusters, Innovation Culture and Government Policies. The Government policies include IPR, S&T policies, Industrial Policies, Taxation policies, Laws etc. The development of the Innovation Culture is a specialized job and depends upon more than 80 parameters. In addition to this, Hundreds of factors drive innovation. When the Innovation Ecosystem concentrates in one region then it becomes Innovation Cluster and becomes major source of innovation. The innovation clusters generally grows around renowned Universities. In this context, the role of the university should be towards the development of innovative employable workforce for the industry, a knowledge hub which provides international talent, center for technology transfer, platform for international collaborations with academia, industry, research labs, government agencies etc. All these factors are important Drivers for Innovation. The Innovation happens mostly in Industry. The National R&D units and Universities should play mainly a supportive role.



The complexities of Innovation Ecosystem can be visualized with the help of above diagram. The inner dynamics of National Innovation Ecosystem can be understood in a better way, if we could analyze the pattern of Innovation Ecosystem of other top most innovative nations like Japan, South Korea, Taiwan, US, China, Israel, Hong Kong and Singapore.

I have divided the book in to 4 parts. The **1st part** covers the various concepts related to Innovation and related case studies. In the initial 3 chapters, I have introduced almost every element mentioned in above diagram. These concepts are essential to understand the rest of the book.

The **2nd part** is dedicated for "**How to inject innovation in to any organization?**" The 4th chapter gives broad idea for developing Innovation Culture in any organization. In chapter 5, I have tried to highlight the difference between Research and Innovation. The chapter 6 highlights the role of university with respect to innovation. In chapter 7, various techniques for enhancing Innovation Competencies have been discussed. The way to introduce the innovation in to University environment has been discussed in chapter 8.

In the **3rd part**, I have highlighted the status of Innovation in India. I have also tried to present the detailed analysis of our National Innovation Ecosystem along with vital components. In chapter 15, I have explained the Frugal Innovation, which is secret weapon of Emerging Markets.

In **4th part** of this book, I have discussed the complex issues like GDP, Stages of Economy, Approaches of Developed Nations, Role of WCU, National Policies and International Scenario. In chapter 16, I have discussed the relationship between developed nation and WCU along with Innovation. In chapters 17, 18, and 19, I have discussed the Innovation Ecosystem of South Korea, Japan, Taiwan, USA, China, Israel, Hong Kong and Singapore, which gives the clues to develop strong Innovation ecosystem suitable to Indian culture and environment.

In the last chapter "Final Word", I have correlated all the concepts and presented the inner dynamics based on the fact and figures.

I would like to ignite human brain for innovation through this venture. I am sure once you read the few pages of this book, you will be in love with this book. It's for everybody; from industry to academia; from government authorities to office staff; from parents to students; from faculty of medicine or engineering to faculty of Arts; from Stock Exchange to Venture Capital funding agencies; from Defense to Pharmaceutical business; from small scale businessman to corporate house. I have written this book in such way that everybody should be benefited and start thinking creatively.

I have gone thorough half million pages while writing the series of 6 books on World Class Universities and found that the academicians are overstretching the role of World Class Universities with respect to Research and Innovations. No doubt that for the building of nation the University plays a crucial role but the role of industry is more prominent. Remember that major source of Innovation is Industrial R&D centers and not the Universities. The industrial R&D can enhance the industrial sector and in turn build the national economy and pave the way to become Developed Nation. To justify this stand I have considered the example of **South Korea**, which has become developed nation without focusing many aspects of universities like

- Research
- Patent and Technology Transfer

- Internationalization

For many years the South Korean Universities only focused on employability of the students. They focused on WCU when they were very close to Developed Nations.

I have compiled this information in the form of book for national interest. How to improve the university or higher education institute is always a major challenge faced by all the academicians. For helping them to find this information at one place, I have put these efforts and published series of six books. The credit of each point mentioned here goes to respective authors mentioned in the references. I am amazed to see their enormous contribution in the field of higher education. I could refer only few articles written by them and could include very few points in this book. For detailed information regarding any issue, please refer their original articles and if needed search their other articles on the Internet. This is not just 600 pages compiled work but pointers to articles of thousands of pages, contributed by authors, who have spent their lives for the cause of education of mankind. I am thankful to them.
I had introduced hundreds of problems, suggestions, remedies and best practices through my series of 6 books on World Class Universities, with more than **2300** pages and **2400** references. I have referred thousands of documents from around 40 countries and gone through beyond **5 Lakh pages**. With GOD's grace, I could reach to more than 5 Lakh academicians across the world and could ignite the minds of young faculty, researchers and students across the nation. In this pretty long journey, I was not alone. Thousands of academicians were constantly encouraging me to compete this gigantic task. I am thankful to them. The valuable comments of high profile readers are available at http://dharaskar.com/world-class-university-book-5.html

I have taken maximum care to give the authentic information but in case at some place, if you find some discrepancies then forgive me and help me to correct it in the next edition of this book. I am sure; the readers will like and welcome my sincere efforts to enhance the Indian Innovation Ecosystem and standards of higher education system. I hope this book will act as catalyst and will help in improving the overall Indian Innovation Ecosystem, which can compete with the rest of the world.

Dr. Rajiv V. Dharaskar

About Author

He is Director, MPGI Group of Institutes Integrated Campus Nanded. He is former Professor and Head, PG Department of Computer Science and Engineering, G H Raisoni College of Engineering, TEQIP II beneficiary Autonomous Institute, Nagpur. He had started his career at MIET, Gondia (1984-2008).

He is Ph.D. in Computer Science & Engineering in the Faculty of Engineering & Technology, MTech (Computers), P.G. Dip. (Computers), M.Phil. and M.Sc. He is having 30 years of teaching and 22 years of R&D experience in the field of Computers & IT.

He is an author of the books

- “The Hidden Treasure of C”, BPB Publications
- “Funding Techniques of World Renowned Universities”, Shroff Publication
- “Strategy to Develop the World Class Universities”, Shroff Publication
- "Technology-Storms Redefining World Class Universities", Shroff Publication
- “113 Difficulties in Developing World Class Universities”, Shroff Publication
- “Washington Accord & Multi-Objective Integrated Model for Developing WCU”, Shroff Publication

He has more than 300 research papers to his credit. He has guided 4 PhD scholars, 35 MTech scholars and more than 10 PhD research scholars are working on various subjects like Digital Forensics / Cyber Security, Software / Usability Engineering, HCI, Mobile Computing, E-Commerce, E-Learning etc. He has delivered numerous Keynote addresses at international conferences and serves on several International advisory boards. He is on editorial or review board of prestigious International Journals and worked as a Reviewer for dozens of International Conferences and journals. His details are available at http://www.dharaskar.com

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I am thankful to hundreds of great authors for their wonderful articles and reports on higher education system in India and Abroad, which I have referred to compile this book of national interest. I am thankful to

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Dr. Rajiv V. Dharaskar
Ph.D. (Computer Science & Engineering), M.Tech. (Computers),
M.Phil. (Maths), M.Sc. (Maths), PB Dip. (Computer Science & Applications)
Director, MPGI Group of Institute Integrated Campus, Nanded
Former Professor and Head, Department of Computer Science & Engineering, GHRCE, TEQIP II beneficiary Autonomous Institute, Nagpur
Email: rajiv.dharaskar@gmail.com ,
Website: www.dharaskar.com

Address for Correspondence:
Prof. Dr. Rajiv V. Dharaskar,
Dharaskar Nursing Home,
Railtoly, Gondia, Maharashtra, India 441614

Brief Contents

Detailed Contents

Part I: Introduction to World of Innovation: A Complex Phenomenon & Growth Engine for Nation

*Report of US Patent & Trademark Office stated that "**Innovation**—the process through which new ideas are generated and successfully introduced in the marketplace—is a primary driver of **U.S. economic growth** and national competitiveness…Intellectual property (IP)-intensive industries support at least **40 million jobs** and contribute more than **$5 trillion dollars** to **U.S. GDP i.e. 34.8 % US GDP."** [244]*

*"**No country can progress without innovation**. Higher educational institutions can take a leading role in encouraging innovative activities" President of India Hon. Pranab Mukherjee [73]*

*Business Portal of Government of India stated that "In the ever-changing world, **innovation is the only key which can sustain long-run growth of the country**. More and more firms are realizing the **importance of innovation** to gain competitive advantage. Accordingly, they are engaging themselves in various innovative activities, ranging from manufacturing processes, product improvement, brand building initiatives to customer satisfaction… Indian firms **need to recognize the importance of 'innovation'** for maintaining their competitive edge and fuelling further growth." [314]*

"Innovation distinguishes between a leader and a follower."- Steve Jobs American Entrepreneur Apple co-Founder

Chapter 1: Introduction to Concept of Innovation

In India, innovation became part of the national policy when the government designated the decade from 2011-2020 as the ***Decade of Innovation****.* *[63]*

President Barack Obama said that "we need to ***out-innovate****, out-educate, and out-build the rest of the world…none of us can predict with certainty* ***what the next big industry will be*** *or* ***where the new jobs will come from****." [225]*

Presentation of Vice President, Georgia Tech University [190]

Many people ***understand the concept****, but* ***don't have the experience*** *of how successful* ***innovation really works****. They create processes and assign teams, and expect that results will follow just like it does in other parts of the business.* ***But innovation is much different than standard operations. It has different rules, clock-speeds, metrics, and processes.*** *[312]*

A recent IBM study of 1,500 CEOs identified creativity as the number-one "leadership competency" of the future. [350]

1.1. Innovation: Nice Buzzword but Often Misunderstood

The article in Wall Street Journal stated that "Innovate or die." "Ideation is the new thing." "It's a game-changer." New this, new that, and blah, blah, blah. On and on we hear about the necessity for breakthrough creativity, to find the next best new thing, service or experience; the next Apple, Starbucks or Amazon. If we are not creating new today, we will be gone tomorrow.

How can we not all agree? Of course we do. But how many entrepreneurs, companies or their leaders **really understand** or agree on what game-changing innovation really is? And, more importantly, **how many really understand** how it is actually accomplished? And, further yet, how do we do it?

The answer to the last three questions is: **very few**. Otherwise there would be more Apples, Starbucks, and Amazons: fundamental "break-through" concepts. [362] [363] [370] [371]

Many people **understand the concept, but don't have the experience** of how successful **innovation really works**. They create processes and assign teams, and expect that results will follow just like it does in other parts of the business. **But innovation is much different than standard operations. It has different rules, clock-speeds, metrics, and processes.** To be successful a company cannot run innovation in the same way it does operations. Leading innovators know how the different pieces fit together into an innovation engine – from envisioning the concept, exploring options, and developing the winning approach, all the way to commercial sales and scales. And leading innovators don't stop there. They make innovation repeatable, scalable, and dependable – to accelerate growth and serve the company both today and tomorrow. [312]

David Parekh, Vice President, United Technologies Research Center USA stated that "I think that starts with leadership: being able to articulate why innovation is important. People can easily articulate things about infrastructure or about tourism, sports - Who's going to win the Euro Cup? - But they have a harder time to frame innovation, technology and science. It is harder because whereas you can make an investment and say, 'I'm going to build this building and this road,' and you see it as it's being built, when you invest in an innovation ecosystem, it takes some time and often the output might not directly be what you had expected… My point here is that it's very hard to anticipate where innovation will take you, and what it will produce, but you can focus on the building blocks for it." [643]

Take Andy Grove, former Chairman Intel Corp. said that "In my view, the word innovation has become **overused**, clichéd, and meaningless, I detest the mechanism that spits such fads up because they are **so much easier to talk about than to do**." [666]

Albert Einstein once said, "If I had 20 days to solve a problem, I would spend 19 days to define it." **Innovation is a particularly sticky problem because it so often remains undefined**. [489]

Peter Drucker said that "The business has…two basic functions: **marketing** and **innovation**. Marketing and innovation **produce results**; all the **rest are costs**"

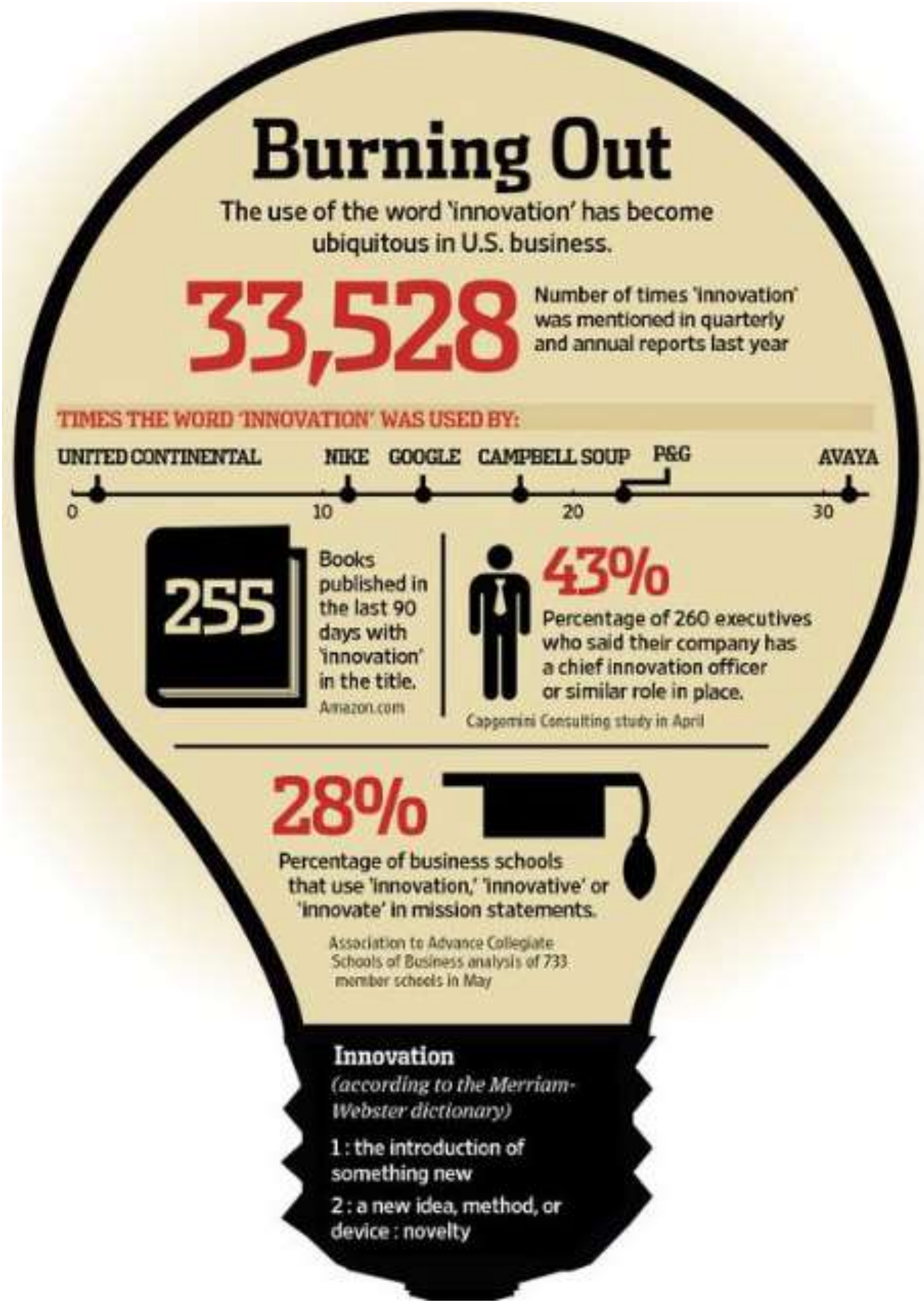


Fig. 1.1: "Innovation" Buzz Word [371]

1.2. Innovation: Definition, Types & Forms

The **National Innovation Council** defines innovation as: "Innovation today is increasingly going beyond the confines of formal R&D to redefine everything. Today innovation can mean

- New and unique applications of old technologies
- Using design to develop new products and services
- New processes and structures to improve performance in diverse areas
- Organizational creativity
- Public sector initiatives to enhance delivery of services

National Knowledge Commission (NKC) defines Innovation in the following manner: 'Innovation is defined as a process by which varying degrees of measurable value enhancement is planned and achieved, in any commercial activity. This process may be breakthrough or incremental, and it may occur systematically in a company or sporadically; it may be achieved by:

- Introducing new or improved goods or services and/or
- Implementing new or improved operational processes and/or
- Implementing new or improved organizational/ managerial processes in order to improve market share, competitiveness and quality, while reducing costs.' [215]

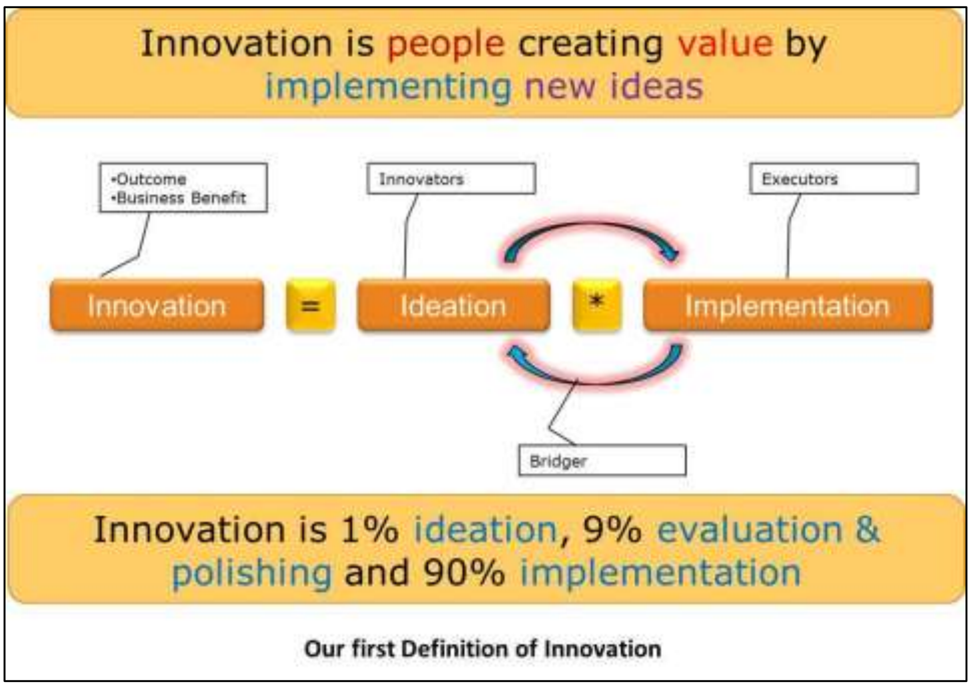


Fig. 1.2: Definition of Innovation [269]

Out of several cases, innovation can basically be:

1. Product innovation (e.g. new goods or services put on sale)
2. Process innovation, which changes the way a given good is produced within the firm or across a supply chain
3. Business Model innovation, when an organizational routine is replaced with a new one

Fig. 1.3: Europe 2020 - Innovation Union: What is Innovation [335]

In short,

- Innovation takes many forms. Innovation can be a process, product, service, or anything that helps firms to perform better.
- Innovation can originate from anyone. Anyone can innovate, as innovation requires a mindset that probes perceived boundaries to bring new ideas to fruition.
- Innovation is not creativity alone. **Innovation is more than creativity** as it begins with an idea and subsequent implementation to produce new value.
- **Innovation is more than improvement**. Improvement is the refinement of existing methods to get more output from the same input while innovation breaks new ground, giving new outputs from less or different inputs.
- Innovation pays in quantum amounts. The impact of innovation results in quantum leaps in value creation that encompasses effective results. [164]

Few fact about innovation:

- Innovation enhances something - Think Google
- Innovation obsolesces something - Think Schwab
- Innovation retrieves something - Think Barnes & Noble
- Innovation reverses into its opposite over time (time bound) - Think e-mail
- Innovation is how many things come together to create value (solutions)
- Growth producing innovation is just as likely to occur in inbound logistics or packaging as it is in marketing or R&D
- Innovation is everywhere because innovation isn't a thing… it's an attribute of many things! [59]

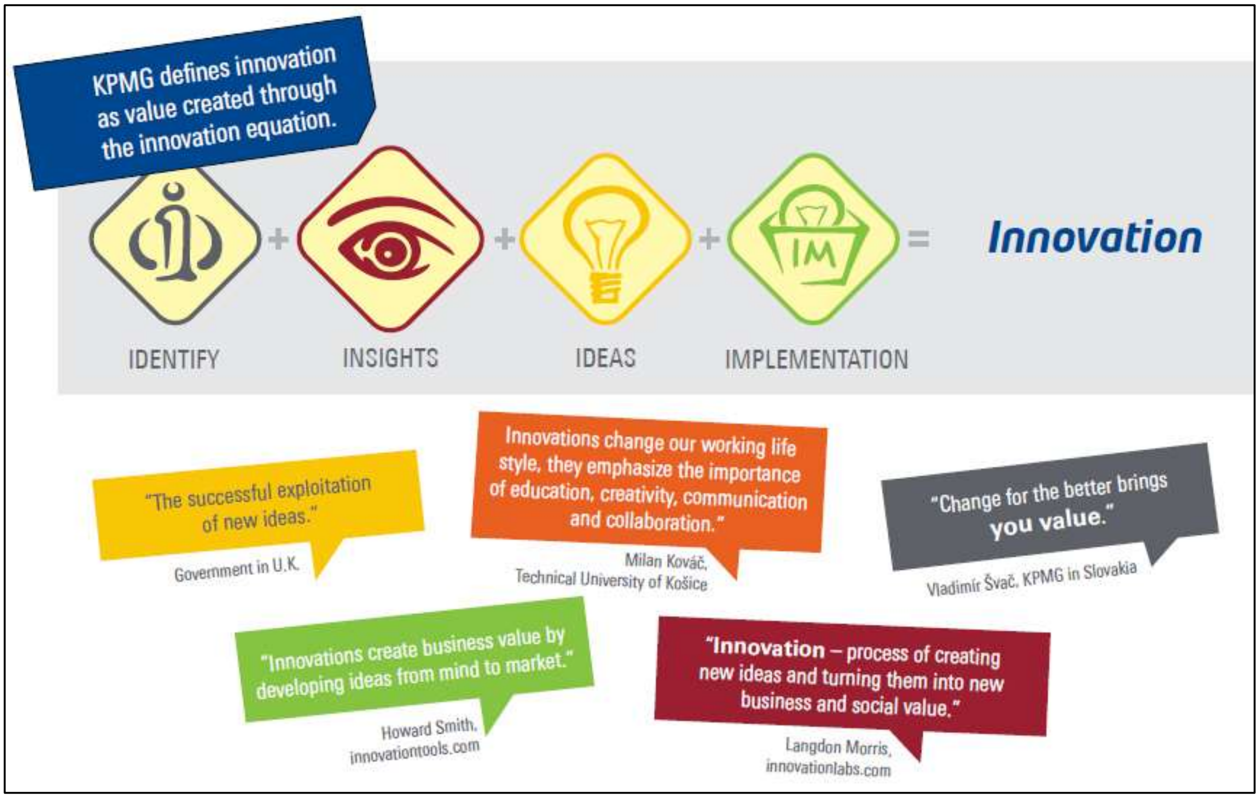


Fig. 1.4: KPMG definition of Innovation [14]

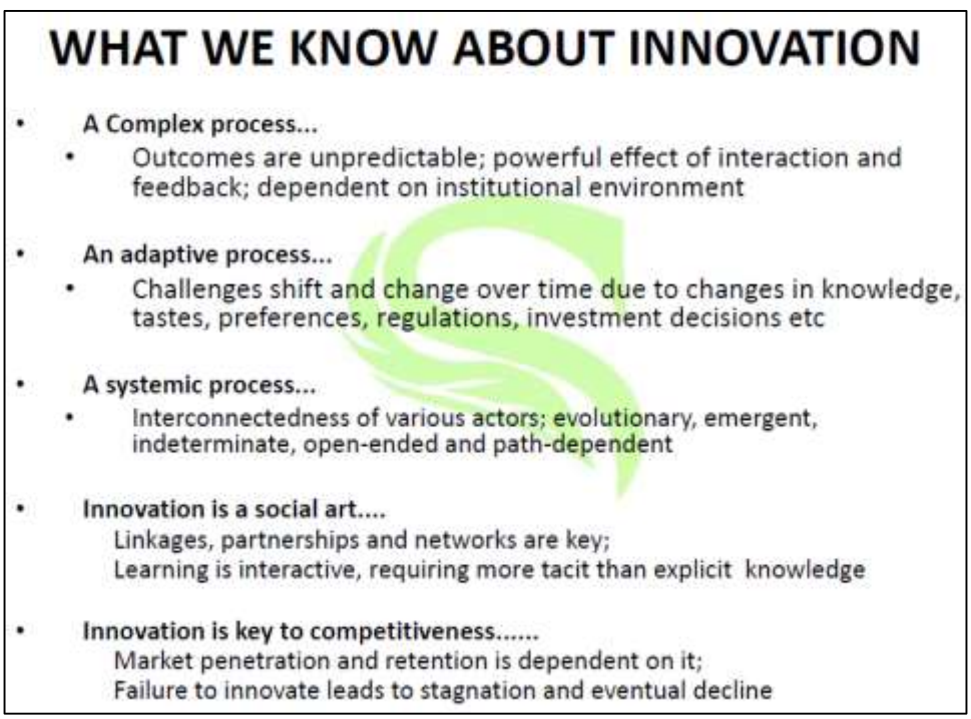


Fig. 1.5: Different meaning of Innovation [51]

1.3. Difference between Innovation, Invention and Discovery

Normally the media has blurred the line between these three concepts and using it interchangeably. Throughout this book I have followed this convention. But these three concepts are altogether different.

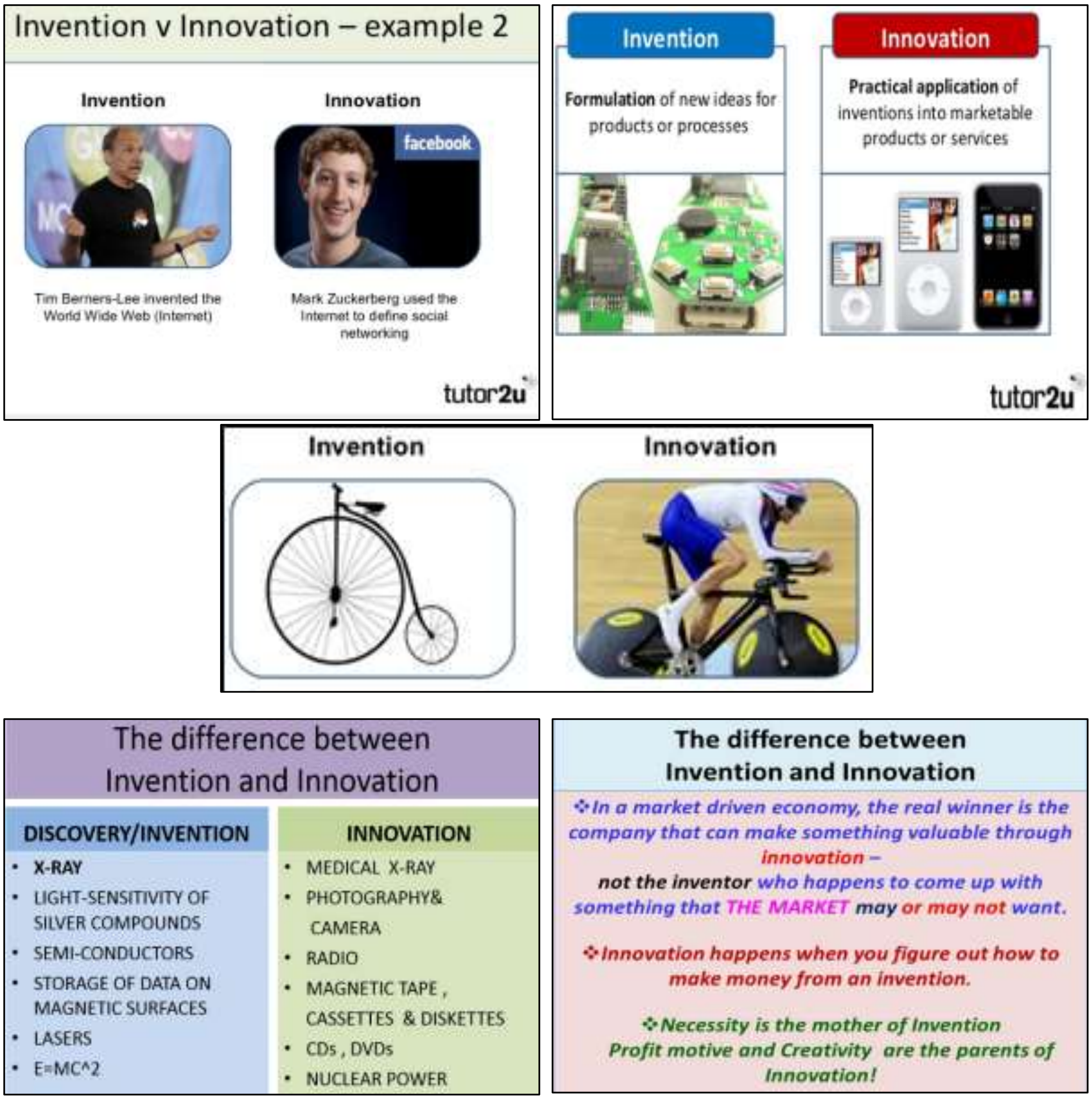


Fig. 1.6: Difference between Invention & Innovation [287] [316]

Discovery:
As in the word, it means to find something which was already exists but not revealed or hidden or not known. For example

- Elements, Islands, Caves, Archaeological findings etc.

Invention:
1. Invention is the creation of new products, processes, and technologies not previously known to exist.
2. Invention is the new device or process. To qualify for a patent an invention must pass a test of originality i.e. be sufficiently different from previous inventions. Most inventions are minor improvements on existing inventions which do not qualify for patents. Only a small percent of patented inventions have any economic value. [285]
3. To create new things which are not already existed or discovered. For example:
- Copper is discovery and bronze is invention.
- Telephone by Gram Bell

Innovation:
1. Innovation is the transformation of creative ideas into useful applications by combining resources in new or unusual ways to provide value to society through improved products, technology, or services.
2. Creating, using the thing (inventions) in different dimensions. A better way of doing things or an improvement.
3. Innovation means doing things differently, and doing different things, to create a step change in performance.
4. Innovation is applying basic discoveries or inventions to produce a useful product or process for a specific application. Product innovation is the development of new and improved products or services; process innovation refers to new or improved methods of production or distribution.
5. **Innovations may not be patented**, even though **often times the distinction between inventions and innovations is blurry**. **Discoveries and inventions are rarely profitable in themselves. Innovation is necessary to bring the product to market economically**.
6. As the Patent Report observes, "**Invention is the first step of innovation**, but innovation often requires significant additional development activity beyond that first step in order to get new products and services to consumers."… Media, still casually refer to invention and innovation interchangeably. [291]
7. A better way of doing things. Innovations can occur in all goal-directed behavior such as profit maximization, reelection politics and personal lifestyles. Thus an innovation improves performance in goal directed behavior as measured by a criterion. An example of a criterion would be profit maximization in business. [285]
8. To turn an invention into an innovation, a firm typically needs to combine several different types of knowledge, capabilities, skills and resources from within the organization and the external environment. [347]

For example
- Telephone is an invention. Every innovation gave it new dimension like Touch Tone Phone (old land line model), cordless phone, and mobile phones.

- Spreadsheet software is an invention. A new business application of spreadsheets that increases profits is an innovation.

Apple's iPod: How did Apple do it?

- Increase revenue more than 1,200% since 2000
- Increase net profit more than 3,000% since 2000
- Increase market cap more than thirty five times to over $300 billion and counting. [309]

The iPod wasn't the first portable music device (Sony popularized the "music anywhere, anytime" concept 22 years earlier with the Walkman); the iPod wasn't the first device that put hundreds of songs in your pocket (dozens of manufacturers had MP3 devices on the market when the iPod was released in 2001); and Apple was actually late to the party when it came to providing an online music-sharing platform. Napster, Grokster and Kazaa all preceded iTunes. So, given those sobering facts, is the iPod's distinction as a defining example of innovation warranted? Absolutely. What made the iPod and the music ecosystem it engendered innovative wasn't that it was the first portable music device. It wasn't that it was the first MP3 player. And it wasn't that it was the first company to make thousands of songs immediately available to millions of users. What made Apple innovative was that it combined all of these elements — design, ergonomics and ease of use — in a single device, and then tied it directly into a platform that effortlessly kept that device updated with music. Apple invented nothing. Its innovation was creating an easy-to-use ecosystem that unified music discovery, delivery and device. And, in the process, they revolutionized the music industry. [286]

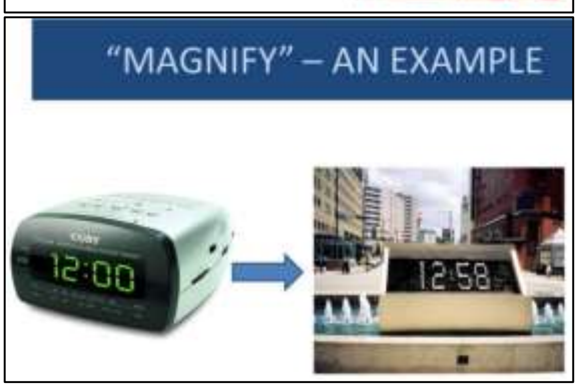
1.3. Interesting Techniques of Innovations: SCAMPER

SCAMPER is an acronym for seven thinking techniques that help those who use them come up untypical solutions to problems. The thinking techniques are so common to human creative behavior that it might be more accurate to call SCAMPER a mnemonic for the collection of techniques rather than a technique of its own. A variation of SCAMPER includes an eighth technique and is therefore called SCAMPERR. [288] [290]

SCAMPER is an acronym created by Bob Eberle to represent a set of idea-triggering questions. Some of these questions were originated by Alex Osborne - the advertising guy who invented Brainstorming. You can use SCAMPER as an excellent creative thinking exercise. Generate new ideas with it. Come up with groundbreaking new concepts. Revolutionize your business. [289]

- S Substitute: Remove some part of the accepted situation, thing, or concept and replace it with something else.
- C Combine: Join, affiliate, or force together two or more elements of your subject matter and consider ways that such a combination might move you toward a solution.
- A Adapt: Change some part of your problem so that it works where it did not before.

- M Modify: Consider many of the attribute of the thing you're working on and change them, arbitrarily, if necessary. Attributes include: size, shape, other dimensions, texture, color, attitude, position, history, and so on.
- P Purpose (Put to other use): Modify the intention of the subject. Think about why it exists, what it is used for, what it's supposed to do. Challenge all of these assumptions and suggest new and unusual purposes.
- E Eliminate: Arbitrarily remove any or all elements of your subject, simplify, reduce to core functionality
- R Reverse: Change the direction or orientation. Turn it upside-down, inside-out, or make it go backwards, against the direction it was intended to go or be used.
- R Rearrange: Similar to Reverse, modify the order of operations or any other hierarchy involved. [290]



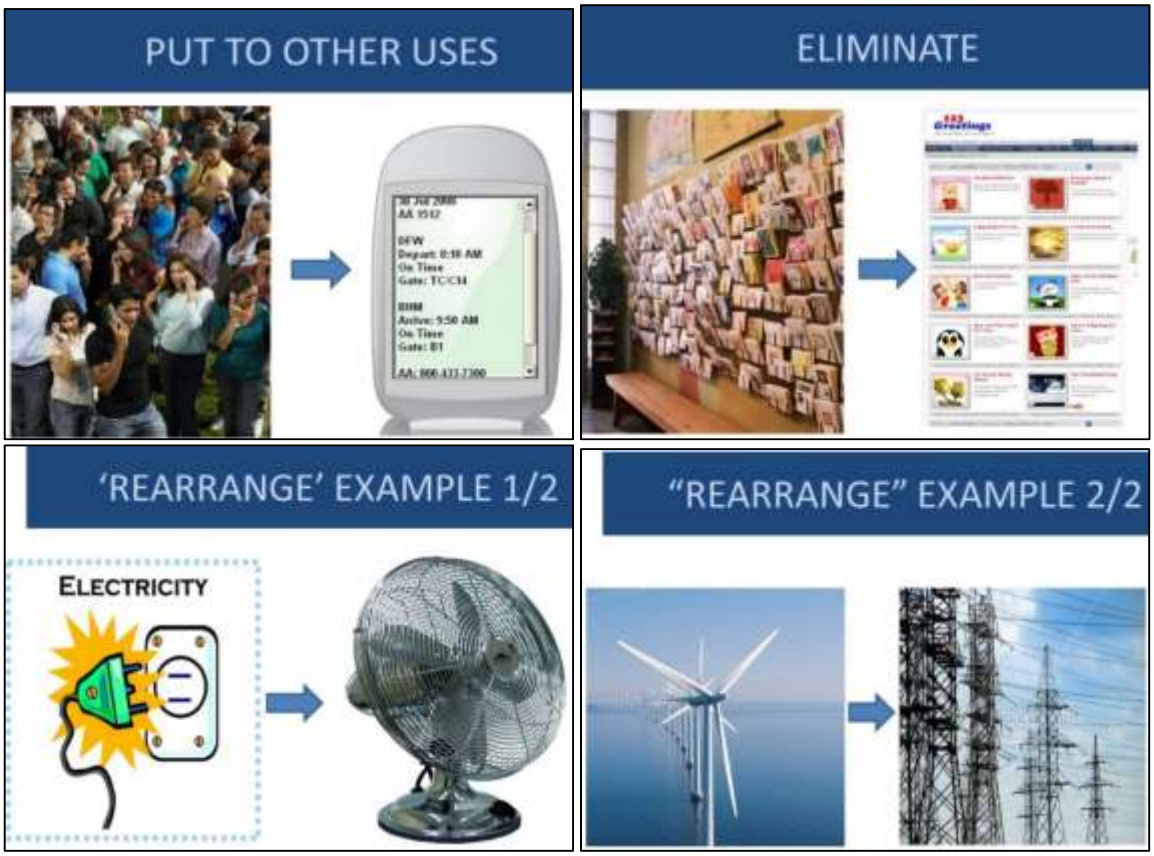


Fig. 1.7: SCAMPER: The 7 Techniques for Innovations [287]

The notebooks of Thomas Edison, one of the world's greatest inventors, show that he often **recombined existing ideas in novel ways**. For example, Edison recombined ideas from both the **telegraph** and the **telephone transmitter** to generate a new idea that led to the invention of the **phonograph**. He realized that a vibrating needle point would leave indentations on a piece of paper (features of a telegraph) – the indentations could then be played back (features of a telephone transmitter). By changing paper to tin foil, he generated an invention where human voice would vibrate a diaphragm, moving a stylus which leaves grooves on the tin foil. When the machine is returned to the starting point, the grooves cause the diaphragm to vibrate again, reproducing the original sound. As this example shows, transformation and combination of ideas often occur within individual actors, demonstrating that individuals, on their own, transform and add value to ideas. [609]

1.4. Difference between Creativity (Ability) & Innovation (Process)

The term creativity and innovation are often used interchangeably; however, there is a clear **distinction** between creativity and innovation, the former being the **generation of ideas** and the

latter its implementation. Sternberg and Lubart (1999) define **creativity** as “the **ability** to produce work that is both novel and appropriate and **innovation** is about “a **process** of developing and implementing a new idea”. No innovation is possible without the creative processes. In this era of globalization and competition, creativity and innovation are considered to be key factors for survival, success and excellence of organizations. [53]

Often the term innovation gets confused with creativity, according to Barry Conchie, principal leadership consultant at Gallup “Let's be clear: Innovation and creativity are not the same thing. Creativity may spur innovation, but there's an element of action missing there. The difference is that innovation actually brings ideas to life. You can't get innovation without a groundswell of creativity. But you must turn creativity into something that has an impact beyond the conversation you had about the idea. Innovation is more than an idea -- it takes place when great ideas actually happen and make their mark on the world.” [258]

Fig. 1.8: Creativity and Innovation [265]

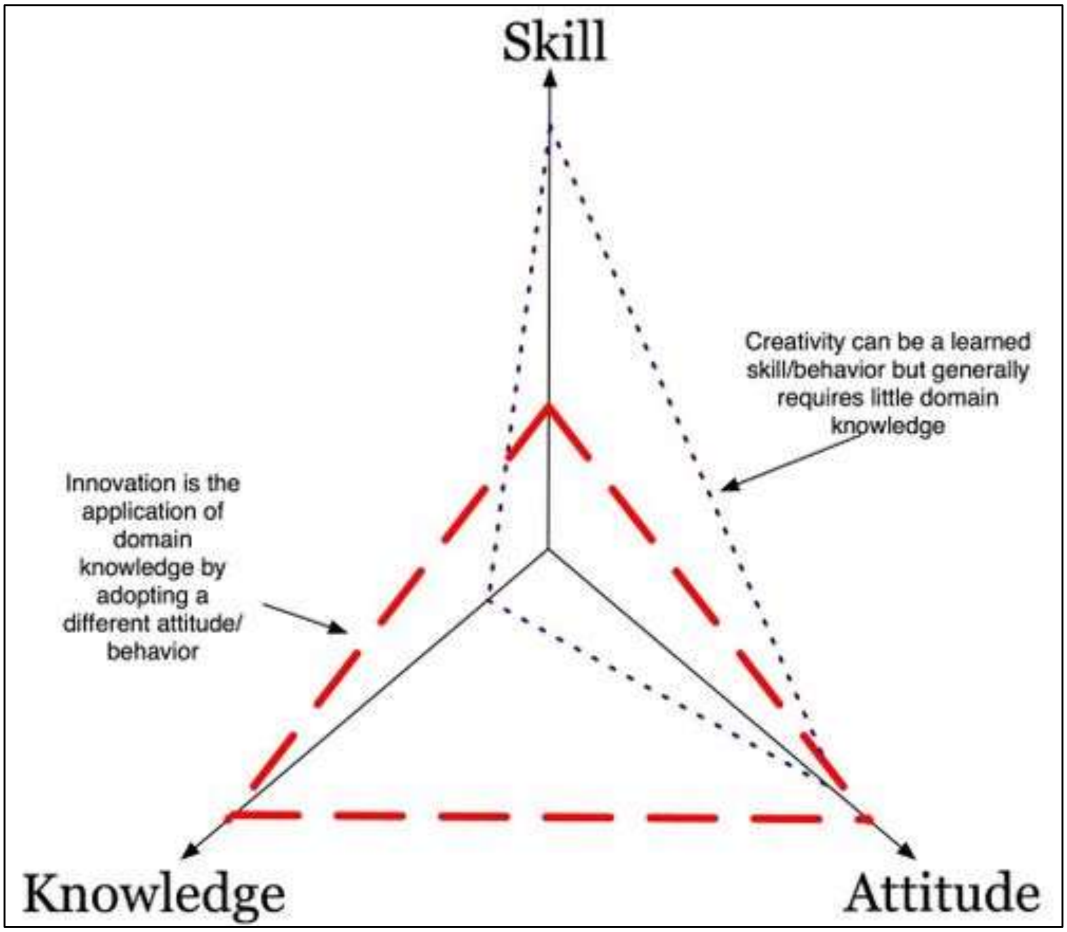


Fig. 1.9: Creativity and Innovation: Relation with Knowledge, Attitude, and Skill [266]

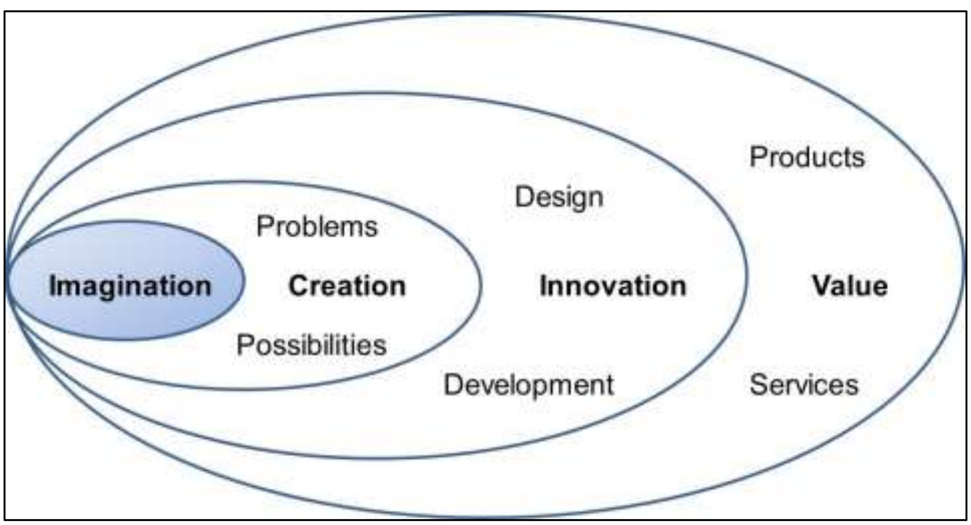


Fig. 1.10: Imagination, Creativity, Innovation and Value [267]

1.5. Creativity, Innovation and Entrepreneurship

Following figure presents the basic concept of innovation, as defined through the research. Creativity, on the one hand, generates ideas and inventions; on the other hand, entrepreneurial proactivity transforms these ideas and inventions into added value innovations. Therefore the innovation process within the basic product (which requires modelling, prototyping and testing) captures other elements of entrepreneurship as well (manufacturing, distribution, financing, marketing, etc.). [304]

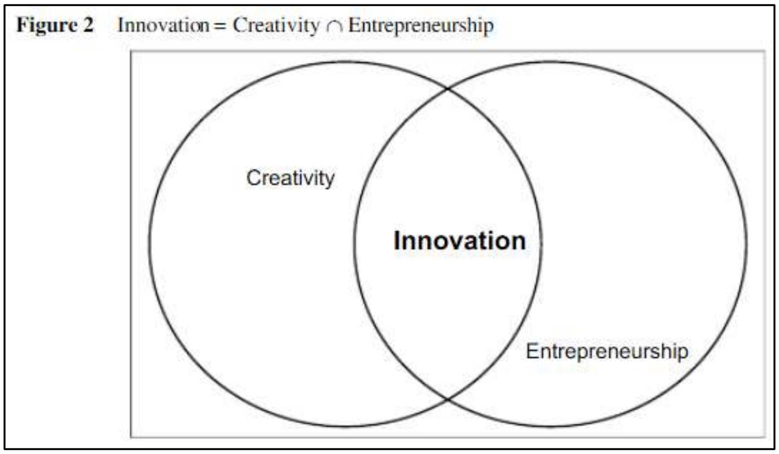


Fig. 1.11: Creativity, Innovation and Entrepreneurship [304]

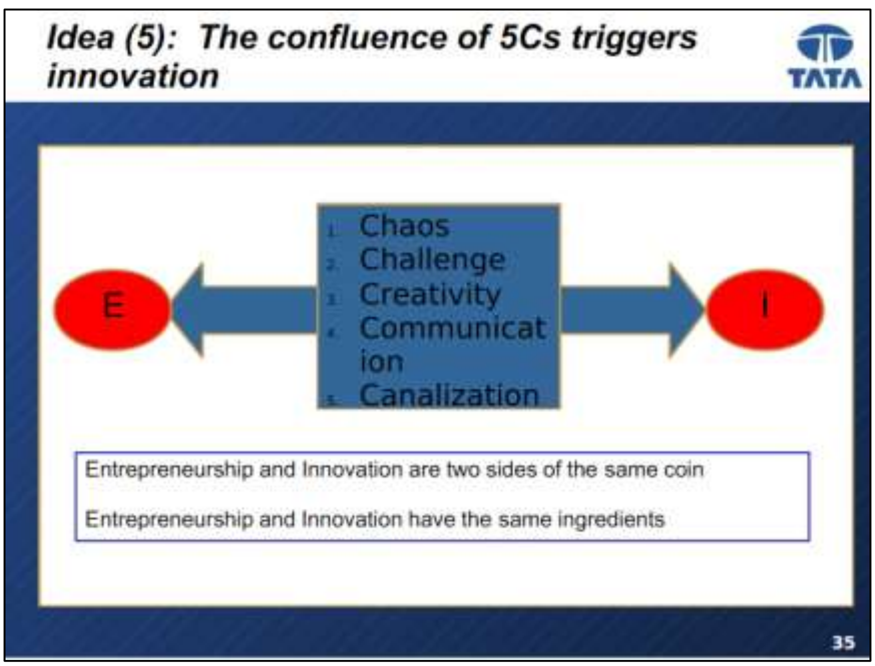


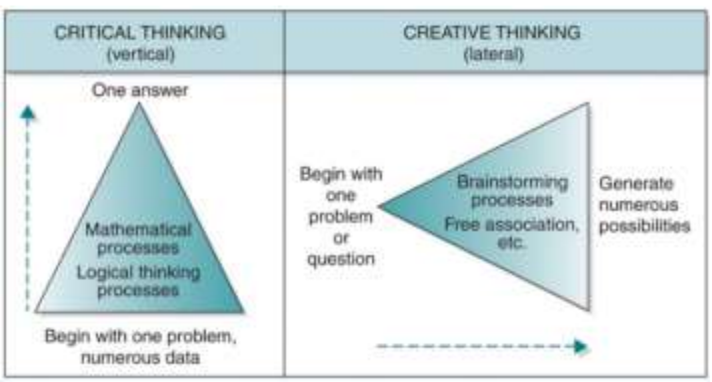
Fig. 1.12: Presentation on Innovation by R. Gopalakrishnan, Director Tata Sons [413]

1.6. Critical Thinking and Creative Thinking

How does creative thinking differ from critical thinking? Generally, critical thinking is analytical, logical, and results in one answer or just a few alternatives. Critical thinking is often described as vertical, logically moving upward until you arrive at a correct answer. By contrast, creative thinking is described as lateral, spreading out to find many possible solutions. [306]

For example, suppose that you, as a marketing specialist, have been assigned to join a special citizens' task force in your community. The task force is considering the problem of how to persuade families and tourists to take their vacations in your home state this year. Notice that there is not merely one answer to this; there are perhaps hundreds or thousands of ways to persuade people to take their vacations in your state. Notice, too, the need for imagination and the prospect of generating many ideas. [306]

By contrast, consider any mathematical problem whose solution has a single answer. Such a problem involves critical thinking; information is analyzed to determine the one best or correct solution. If your task force has generated a large number of suggestions, it will need to use critical thinking in order to decide which ones would be best to implement. Further, critical thinking skills will be necessary in order to arrive at a viable plan of action. [306]



Critical Thinking	Creative Thinking
analytic	generative
convergent	divergent
vertical	lateral
probability	possibility
judgment	suspended judgment
focused	diffuse
objective	subjective
answer	an answer
left brain	right brain
verbal	visual
linear	associative
reasoning	richness, novelty
yes but	yes and

Fig. 1.13: Critical Thinking and Creative Thinking [24] [306]

Inhibitors of Creative Thinking

Personal Block	Problem Solving Blocks	Contextual Blocks
▪ Lack of self-confidence ▪ A tendency to conform ▪ A need for the familiar/habit-bound thinking ▪ Emotional "numbness" ▪ Saturation ▪ Excessive enthusiasm ▪ Lack of imaginative control	▪Solution fixedness ▪Premature judgment ▪Habit transfer ▪Use of poor approaches ▪Lack of disciplined effort ▪Poor language skills ▪Rigidity	▪Scientific reasoning provides a panacea ▪Resistance to new ideas ▪Isolation ▪Negative attitude toward creative thinking ▪Autocratic decision making ▪Experts ▪An over-emphasis on competition or cooperation

www.competingvalues.com The Creative Edge William Miller 48

Fig. 1.14: Inhibitors of Creative Thinking [59]

Sternberg's 1996 book, How to Develop Student Creativity, lists 25 steps that can promote creativity in the classroom:

The Prerequisites
1. Modeling Creativity
2. Building Self-Efficacy

Basic Techniques
3. Questioning Assumptions
4. Defining and Redefining Problems
5. Encouraging Idea Generation
6. Cross-Fertilizing Ideas

Tips for Teaching
7. Allowing Time for Creative Thinking
8. Instructing and Assessing Creativity
9. Rewarding Creative Ideas and Products

Avoid Roadblocks
10. Encouraging Sensible Risks
11. Tolerating Ambiguity
12. Allowing Mistakes
13. Identifying and Surmounting Obstacles

14. **Add Complex Techniques**
15. Teaching Self-Responsibility
16. Promoting Self-Regulation
17. Delaying Gratification

Use Role Models
18. Using Profiles of Creative People
19. Encouraging Creative Collaboration
20. Imagining Other Viewpoints

Explore The Environment
21. Recognizing Environmental Fit
22. Finding Excitement
23. Seeking Stimulating Environments
24. Playing to Strengths

The Long-Term Perspective
25. Growing Creatively
26. Proselytizing for Creativity

Table 1.1: Twenty Six steps that can promote creativity in the classroom [358]

1.7. Strategy vs. Innovation

Unfortunately, innovation is often conflated with strategy. Strategy, after all is a coherent and substantiated logic for making choices, while innovation is a messy business which creates novel solutions to important problems. Put simply, strategy is about achieving objectives, while innovation is about discovery, we never know exactly where we're going until we get there. In other words, while **strategy creates a clear path to a goal**, **innovation is often confused**. [276]

1.8. Where do Innovation come from?

In business, innovation can come from a variety of different sources. Sometimes it is the result of specifically focusing on creating new ideas, whereas other times it can be unexpected and the result of a spontaneous reaction to a particular need. Ideas take on many forms and can be found in the most unlikely of places. The role of an innovation leader within a company is to identify the likely sources for these ideas, and put the processes in place to properly gather them for effective evaluation and use within the organization. [324]

- **Employees**: The main source of business innovation is directly from employees. Your employees know the specific part of the business that they are involved with very well. Therefore, innovations come naturally to them. As they go about day to day operations, employees identify areas that are in need of improvement or could be done differently. Often, they will have their own ideas about solutions to problems or ways to address certain needs. Encouraging employees to bring these ideas forward and then supporting their development can significantly increase the amount of successful innovation in your business. Employees can also be asked to specifically focus on innovation. Many businesses set aside time and conduct group 'brainstorming' sessions to encourage the creativity and the generation of new ideas that the business can investigate and pursue further. [323]
- **Customers**: Another important but commonly overlooked source of innovation are customers. Your customers know what they want and often have innovative ideas about how their needs could be better met through new products and services. Taking the time to listen to what your customers are saying can greatly increase the Sources of Innovation amount of innovative ideas that flow into your business. [323]
- **Business Competitors**: Your business competitors can also be a source of innovation. The important thing to remember is not to simply copy the products your competitors are successful with, but to analyze them and work out what you could do better. Consider what makes their product a success and try to innovate on that so that you have some form of market advantage over the competition. [323]
- **R&D Departments**: In some industries, the importance of research and development departments cannot be overlooked. Organizations invest large amounts of resources into research and development in order to come up with a new idea that they can make commercially successful. However, you can also conduct research on a small scale by conducting customer and employee surveys or analyzing your past successes and failures. [323]
- **Corporations**: in the world we live in, great ideas sometimes cost a lot of money to develop, especially if they are technology based ideas- most of the money that is used to develop new innovations can be found in companies that set up research and development or business development departments with the sole purpose of discovering innovative ideas. This is great vehicle for innovation to invest in for your company- set-up a group or department who's sole purpose is to come up with new ideas for your company. [322]

- **Outsiders**: Sometimes innovative ideas will come from people who have nothing to do with your industry, they aren't consumers, they aren't inventors, they are random people that make connections between your products and other points of inspiration. The reasons why they are able to make these breakthrough connections is often because they aren't wearing blinkers that develop after spending a long time making the same observations and connections. Their minds aren't boxed. To tap into this pool of innovative ideas- set-up competitions or forums, where potential innovators can present their ideas to your company for some sort of reward. [322]
- **Spill-overs**: This happens with one company comes up with an idea or an innovation, that it doesn't quite know what to do with- and this innovation can then be bought or leased by a company such as yours, it's already been developed and often tested, it just isn't practical to market for the firm that created it. Following this angle will save you money in terms of Research and Development, and also enable you to benefit from outside views and fresh thinking. [322]
- **Look to the Past**: Companies should not disregard old ideas when gathering proposals for new products or product improvements. Ideas are not always abandoned because they were evaluated poorly. Often times, the technology available at the time the idea was submitted would not allow for a cost-effective development and/or process. Existing patents should also be considered and with most US patents readily accessible on the internet, it is a low cost method of gathering ideas. One of the best examples of innovation from past ideas is the answering machine. Originally patented in the 1930s, the concept was not realistically marketable at the time due to the inhibitive costs and poor recording quality. It was not until the 1970s that Casio developed a smaller, higher quality answering machine based off of the same patent. It had taken nearly four decades for technology to render the original patent fully marketable. [324]
- **Look to the Future**: Just as the past can hold a remarkable number of ideas, the future, in the form of young academic researchers, can prove to be just as fruitful. Large companies have been working in conjunction with university research institutions for a very long time. University students are less stifled by industry conventions and are generally more able to come up with new concepts and "think outside the box". Their relative inexperience can be a valuable asset to an organization otherwise full of tenured researchers. Students are more apt to ask questions, solve problems in creative ways, and come up with features relevant to a wider demographic consumer base. [324]
- **Peter Drucker's Seven Sources of Innovation**
    - **The Unexpected**: A success, failure or event that is unplanned for is a clue that the world is changing and that an opportunity is available. These tend to pop up around what everybody knows about a particular product, industry or service. It's not necessary to completely understand why the world is changing, just that it is and how it can be exploited. You carefully tailor a product towards a particular market segment. Despite the careful planning, it fails. The failure may belie that the market is changing beneath you — and your failure may tip you off to this change before your competitors realize it. [325]

A classic example dates back to the early days when Marriott was still a restaurant chain before it diversified into hotels. Management observed that one of their restaurants in Washington, DC was outperforming all others in their chain in terms of monthly revenues. Upon investigation, they found the restaurant was located across from the National Airport. This was before airlines served meals on planes and they discovered that airline passengers would stop by the restaurant and purchase sandwiches and snacks to take on the plane with them. Marriott met with the old Eastern Airlines and suggested they provide food to be served on the plane – thus the beginning of the airline catering business. Of course now many airlines, in an attempt to control costs, have eliminated meals and passengers are left to bringing the snacks with them again. [327]

As an example, the Ford Motor Company developed a new automobile, the Edsel, in 1957. The auto's design stemmed from extensive market research about customer preferences in appearance and styling, yet the Edsel became a total failure immediately after it was introduced. Barely a soul wanted it. Instead of blaming the "irrational consumer", Ford's management decided there was something happening that was not in line with general auto-industry assumptions about the reality of consumer behavior. After reinvestigating the market, they discovered a new "lifestyle segment" to which they quickly responded by producing the superbly designed and produced Thunderbird model - one of the greatest successes in US auto history. Will the highly acclaimed innovation, the GM Chevy Volt follow in the footsteps of the Edsel. [327]

- **Incongruity**: The gap between what “ought to be” and what “actually is” is an invitation to innovate. Such opportunities are usually qualitative rather than quantitative, so they don’t show up “in the numbers.” Incongruities are usually visible to people within an industry, but they have learned to live with them and so ignore them.

Drucker uses the example of shipping before the roll-on, roll-off ship and the container ship. An example of this incongruity existed in the ocean-going freighter industry that was believed to be dying in the 1950s. The major assumption about the industry was that the main expense of the ship was while it was traveling from point A to point B. Considerable efforts were directed at getting faster and more efficient ships, fewer crew members, etc., in order to reduce costs. The assumed problem was that shipping was slow and inefficient, so people made faster and more efficient ships. This made the real problem (congestion at docks) even worse. There was a gap between reality and people’s assumptions about reality. An innovator concluded that these assumptions about the industry were wrong, and that the major costs were while the ship was idle in port, awaiting cargo unloading and new cargo to be loaded. The result was the innovation of the cargo container and the roll-on, roll-off ship and the container vessel. Overall costs were reduced by 60 percent, and the industry survived and has grown dramatically ever since. [325] [327]

There is a discrepancy between what is and what should be. This is a key to developing wildly successful businesses but it's tricky. Facebook is a company that nailed it. Prior to the social network's prolific rise Myspace was the dominant player, but it had its downfalls. Facebook wisely noted what Myspace was vs. what should be and built that platform. The end result? A company that just had an IPO versus. One that has fallen off considerably. One of the best places to look for incongruity is in your own customers. Their complaints and unmet wants are all the hints you need. [326]

- **The process need**. This is the opportunity that perfects a process which already exists, replaces a link which is weak or redesigns an old process around newly available knowledge. Occasionally it makes a process possible via a missing link.

Dropbox.com. Everything about the process of creating an electronic document is precise except sharing it. You spend all that time editing it, cleaning it and spell checking it, only to not have the most recent version. Dropbox.com (and other competitors) expedites this process. [325]

An example might be a restaurant that identifies that people wait too long for their entrees and so decides to hire another chef to speed up creation times. Essentially your company will want to look for all weak links and eliminate them. [326]

- **Changing industry and market structures**. The "status quo" within an industry seems permanent but is actually quite brittle. These opportunities are valuable because they are visible to people outside of a particular industry and because they force everyone within the industry to redefine their business or perish.

Drucker uses the example of the auto industry transitioning from a luxury industry to a mass market. Different participants in the market reacted differently, but the ones that survived acted. For instance, Rolls Royce actually made cars that were more difficult to use and expensive; aiming to hold the luxury market rather than compete in the mass market. [325]

- **Demographic change**: The magic here is pairing the knowledge of demographic with an understanding of what they mean. This requires getting out and talking to the people that are a part of the market being affected by demographic change.

Drucker uses the example of the baby boom and Melville shoes. Melville realized that baby boomers were about to become teenagers and so made shoes that reflected the values of teenagers (fashionable and relatively inexpensive but not high quality). By the time its competitors began copying it, its target market was entering adulthood, so it switched again. [325]

- **Changes in perception**: Whether or not one sees the glass as half full or half empty is extremely important in determining what one wants.

Drucker uses the example of food. Once upon a time, he says, the wealthy dined while the working fed. Now everyone dines and feeds on different days of the week. People view food as both an art and as a necessity, explaining the popularity of gourmet cooking shows with people who eat microwave dinners. [325]

Over time populations and people change. The way they view life changes, where they take their meaning from, and how they feel about things also is modified over time and smart companies must pay attention to this in order to capitalize (and avoid becoming forgotten, a relic of ages past). The "down-aging" which refers to people who look at 50 as being 40. Industries have responded to this, most notably in the cosmetic and personal care industry which provides plenty of solutions to help these people look younger. Full industries are creeping up that make people feel younger. [326]

- **Knowledge based innovation**: This is the superstar of innovation (what most of us picture when we think of the word) and in Drucker's view the riskiest. In essence it is creating new knowledge by applying two separate forms of knowledge.

Google and the search engine. The knowledge (PageRank) based on citation theory was applied to the Internet and then used to create a product, a search engine that functioned more effectively than the search engines that existed at the time. [325]

Intel does this constantly and it's a major part of why they're the leading processor manufacturer today. Constantly paying attention to the latest in both academic research as well as investing heavily in their own R&D, the company has managed to find continual sources of innovation, driving its success. [326]

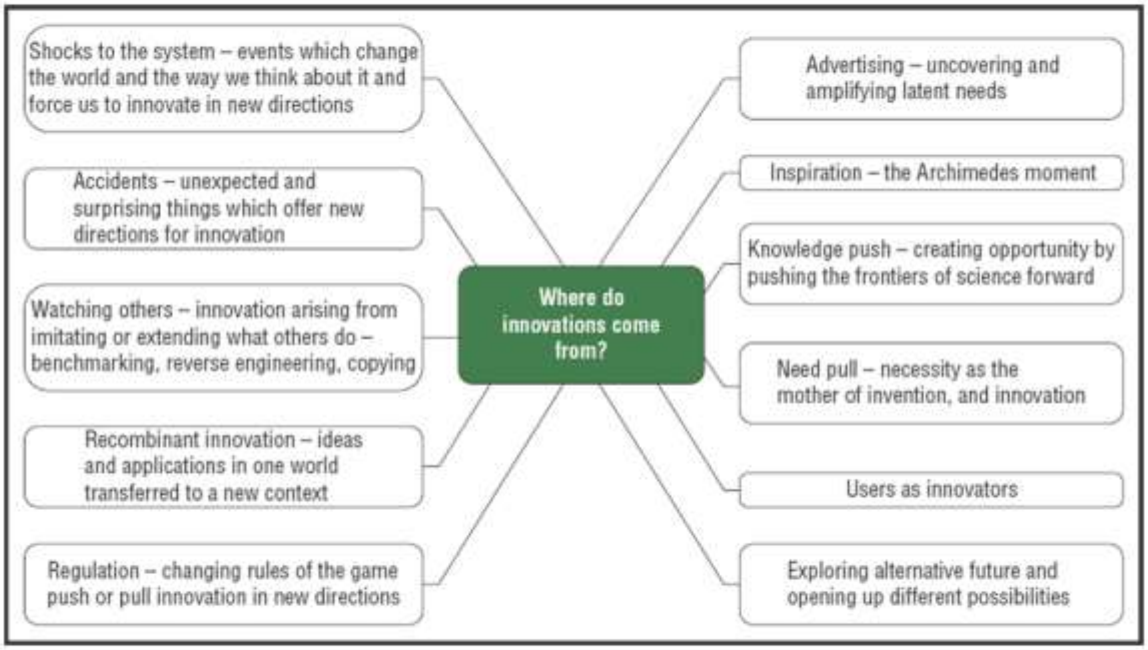


Fig. 1.15: Where do Innovation come from? [264]

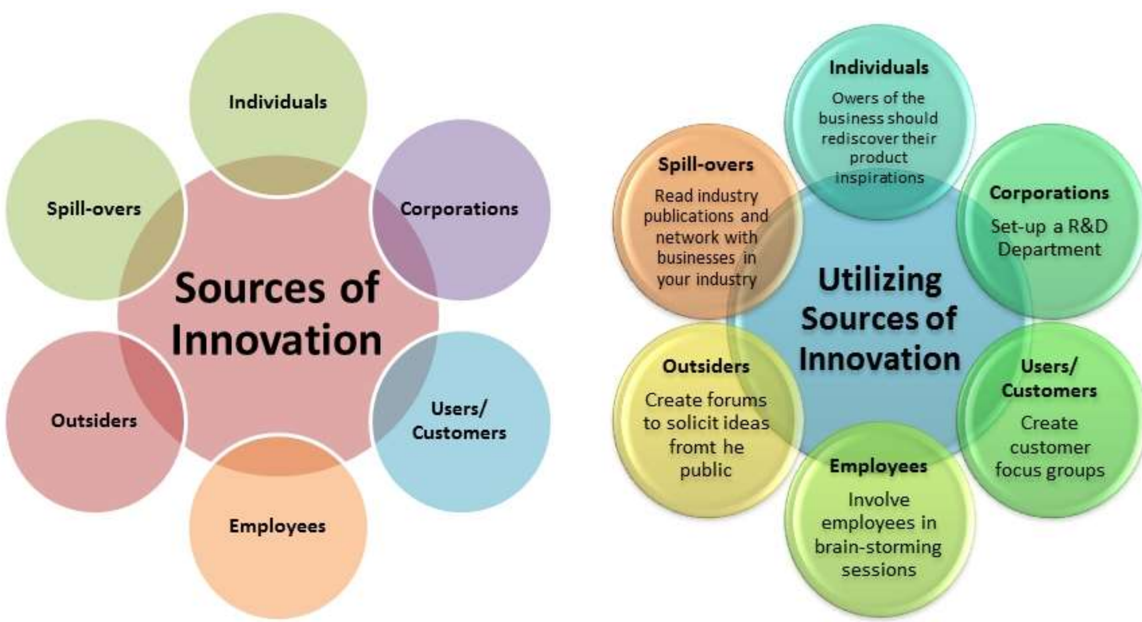


Fig. 1.16: Sources of Innovation and way to utilize these sources [322]

1.9. Death Valley: Workable, Working and Profiting Ideas

Remember that every idea is not innovation or profiting idea. Scaling Innovation is about conversion of risky ideas into innovation through "death valley"

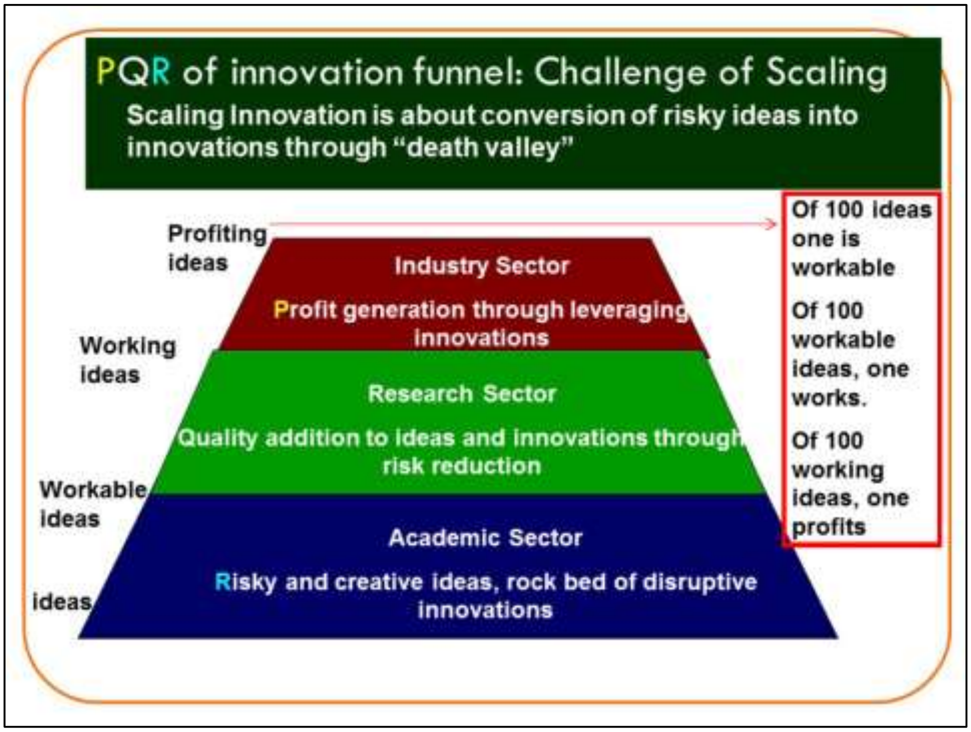


Fig. 1.17: Ideas to Profiting Ideas and role played by Academic, Research and Industry [220]

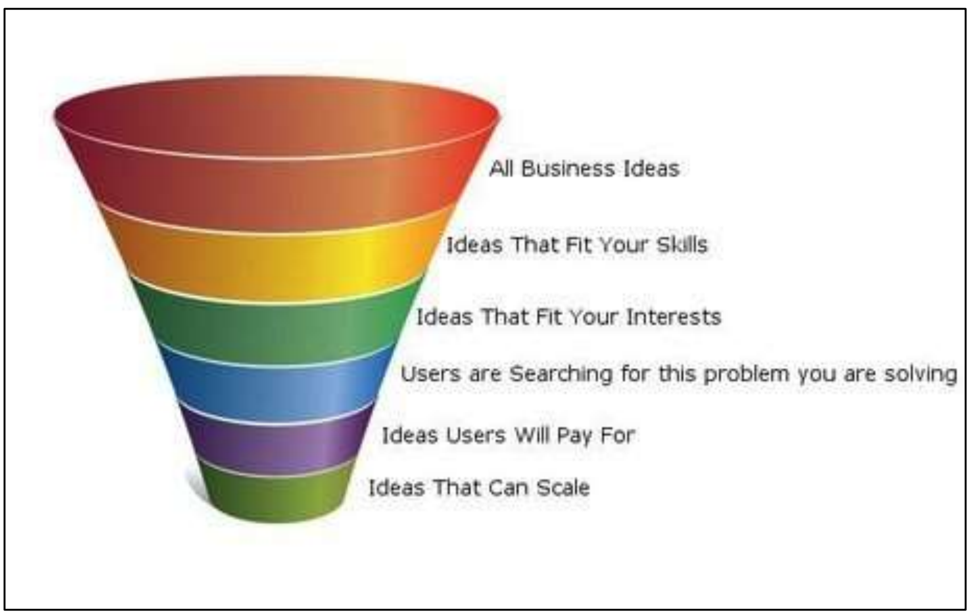


Fig. 1.18: All Business ideas to ideas that User will pay for and can Scale [246]

1.10. Innovation: Publish & Prosper

Research: Publish or Perish
To
Innovation (Patent): Publish & Prosper

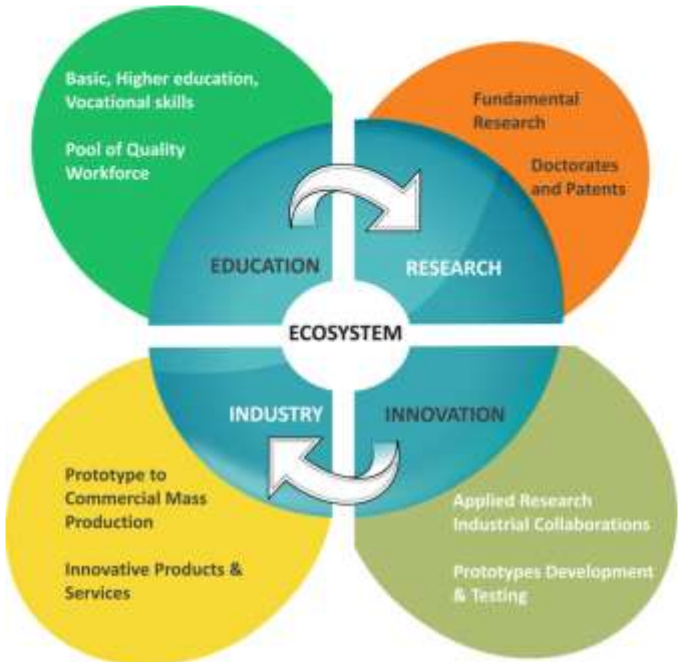


Fig. 1.19: Research and Innovation [213]

Fig. 1.20: Research and Innovation: Presentation of Vice President, Georgia Tech University [190]

1.11. Globalization & Innovation

Globalization itself is a product of innovation. The application of constantly improved technologies to the massive means of transport and communication has produced an unprecedented level of global connectivity, of global awareness. Economies are becoming more interdependent, while cultures are becoming more permeable, transparent and stronger through an intensified exchange of goods, services, ideas, values, experts, problems and solutions. Technology is often at the heart of an innovation. [164]

Gone are the days when innovation was a guarded secret which corporates kept discretely hidden. Research labs would work in isolation afraid that if competitors would get to know about their programs, and innovate faster, the millions spent on current projects would go in vain. **But those were the times when the benefits of global collaboration had not been understood and its economic incentives hugely underestimated**. Now is the **era of globalization and there are no boundaries**. [576]

> If we dissect a new PDA, digital camera phone, notebook PC, or cable set-top box, we will probably find a virtual U.N. of intellectual-property suppliers. The central processor may have come from Texas Instruments or Intel, and the operating system from BlackBerry, Symbian, or Microsoft. The circuit board may have been designed by Chinese engineers. The dozens of specialty chips and blocks of embedded software responsible for the dazzling video or crystal-clear audio may have come from chip designers in Taiwan, Austria, Ireland, or India. The color display likely came from South Korea, the high-grade lens from Japan or Germany. The cellular links may be of Nordic or French origin. If the device has Bluetooth technology, which lets digital appliances talk to each other, it may have been licensed from IXI Mobile Inc., one of dozens of Israeli wireless-telecom companies spun off from the defense industry…This spreading out of R&D is a boon to innovation. By mobilizing global R&D teams around the clock, nimble companies can accelerate development cycles, bringing new technologies to consumers and industry faster, cheaper, and in more varieties. Multinationals can reach deep into once-cloistered university labs in Shanghai or Moscow for help in advancing everything from genetics and molecular research to alternative energy. Besides employing several thousand in India, France, Germany, and the U.S. to develop chip sets and software, Texas Instruments taps brains at 100 info-tech companies from Berlin to Bangalore. This has been vital to maintaining TI's dominance in the $5 billion global market for digital-signal processors for cell phones and consumer electronics. "The more we can leverage outside talent and companies with great ideas, the more product we can get out," says Doug Raser, who oversees TI's global strategic marketing. [576]

1.12. Employability, Education & Innovation

The employability depends upon

- Subject knowledge, which can be enhanced through teaching learning process
- Skillsets which can be enhanced through training activities
- Innovative mind, which can be enhanced through research culture and culture of innovation

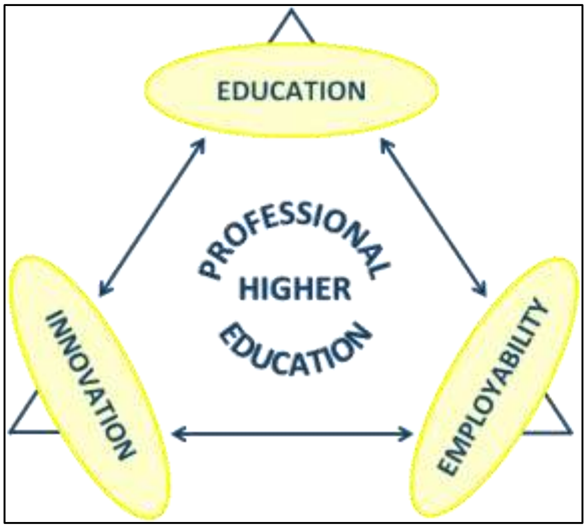


Fig. 1.21: Relation of Education, Innovation and Employability [27]

1.13. Innovation Processes

Is Innovation a Business Process? … I think of innovation as a specific example of a business process. Business processes define how work gets done and how different business functions interact to produce results. Processes represent a collection of related, structured activities or tasks that produce a specific service or product for a particular customer. Often they are visualized in a flowchart as a sequence of activities. Most companies strive to develop efficient, repeatable and usable processes that provide the foundation for achieving business objectives. The business objective of an innovation process could be, for example, a product idea that consumers will buy innovation type and that can be implemented successfully by the company. Other examples of innovation include business innovation, organizational innovation, process innovation, technology innovation, marketing innovation and strategy innovation. Also, it helps to think of business processes as not just being about workflows, but also about the people who bring them to life and the company culture that drives the processes and people. [246]

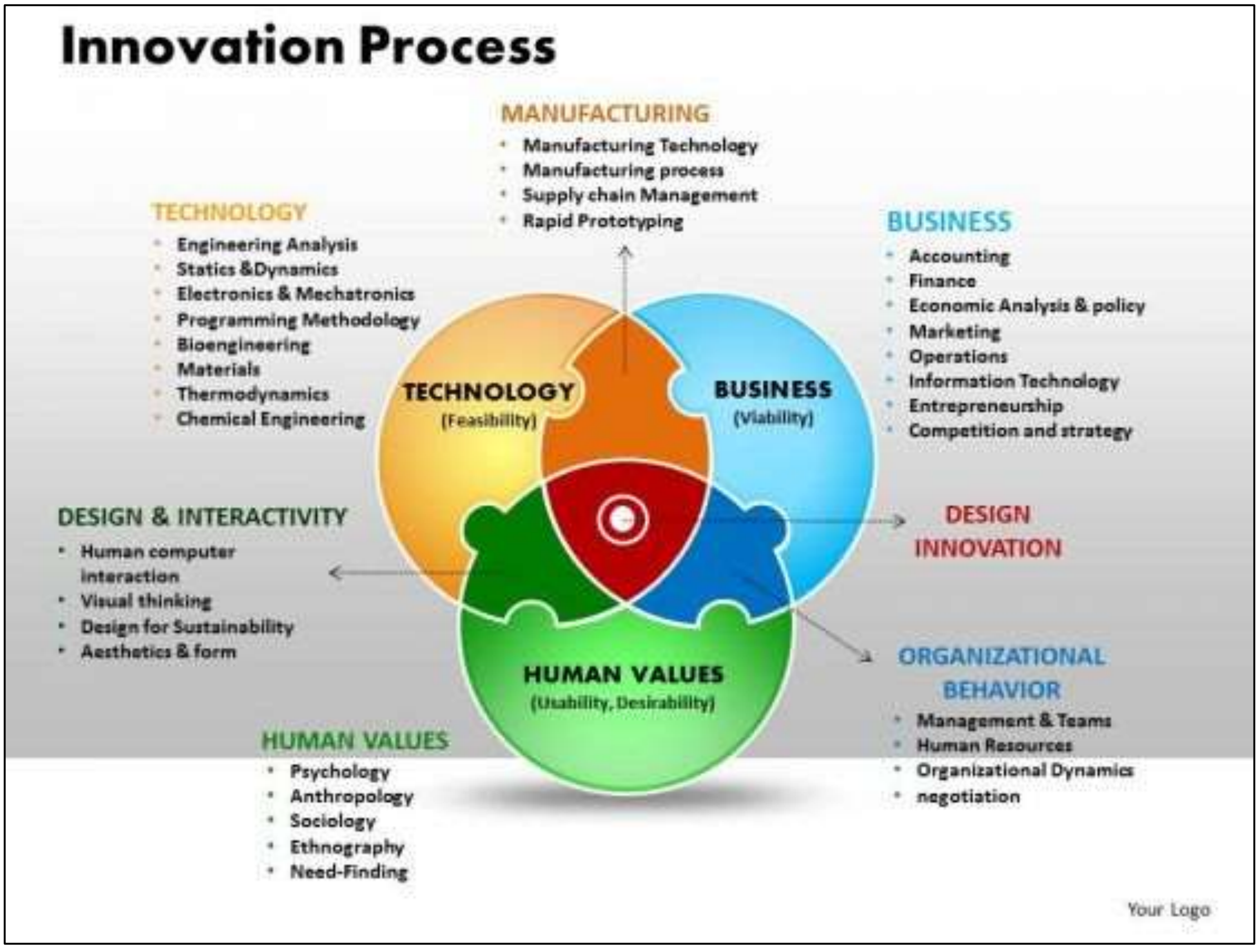


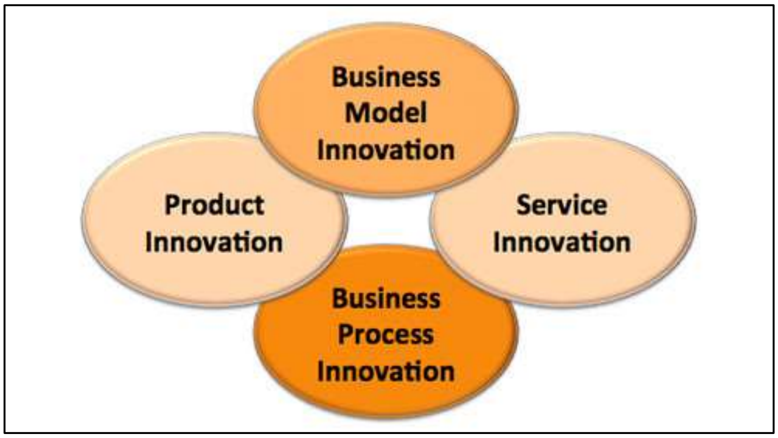
Fig. 1.22: Innovation Processes [245]

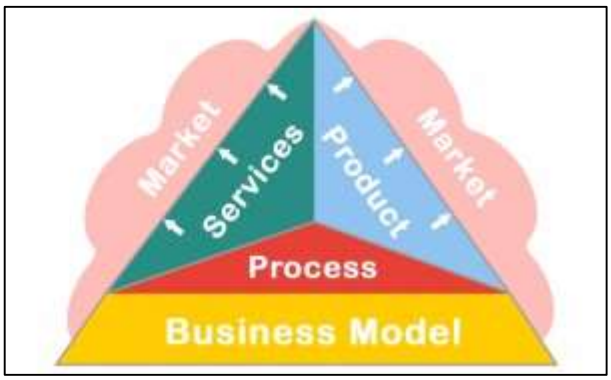
1.14. Types of Innovations

The Innovations can be classified by many ways. Let's see few of them.

1.14.1. Classification: Product, Service, Process, Business Model

- Product
- Service
- Process
- Business Model





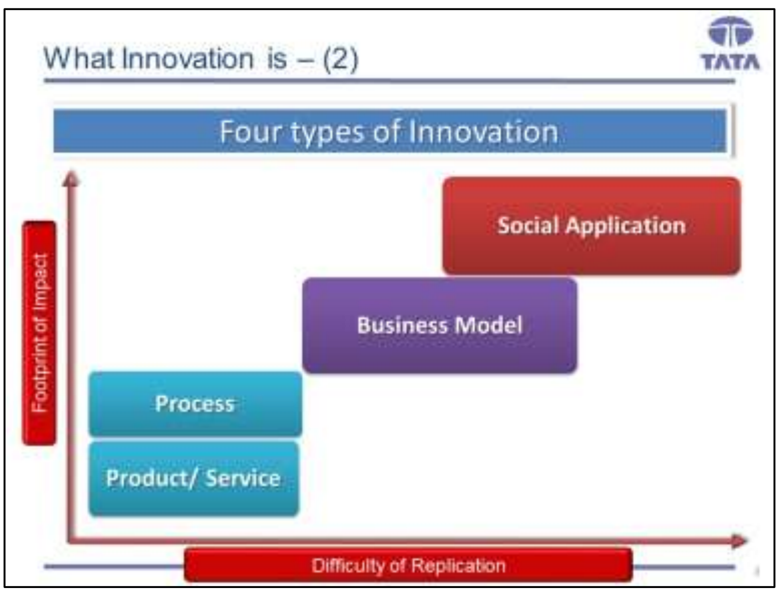


Fig. 1.23: The Four Types of Innovations [263] [277] [414]

Meaning of Business Model: Business model converts **innovation to economic value** for the business. The business model spells-out how a company makes money by specifying where it is positioned in the value chain. It draws on a multitude on business subjects including entrepreneurship, strategy, economics, finance, operations, and marketing. Simply put, a business model describes how a business positions itself within the value chain of its industry and how it intends to sustain itself, that is to generate revenue. In the most basic sense, a business model is the method of doing business by which a company can sustain itself – that is, generate revenue. [622]

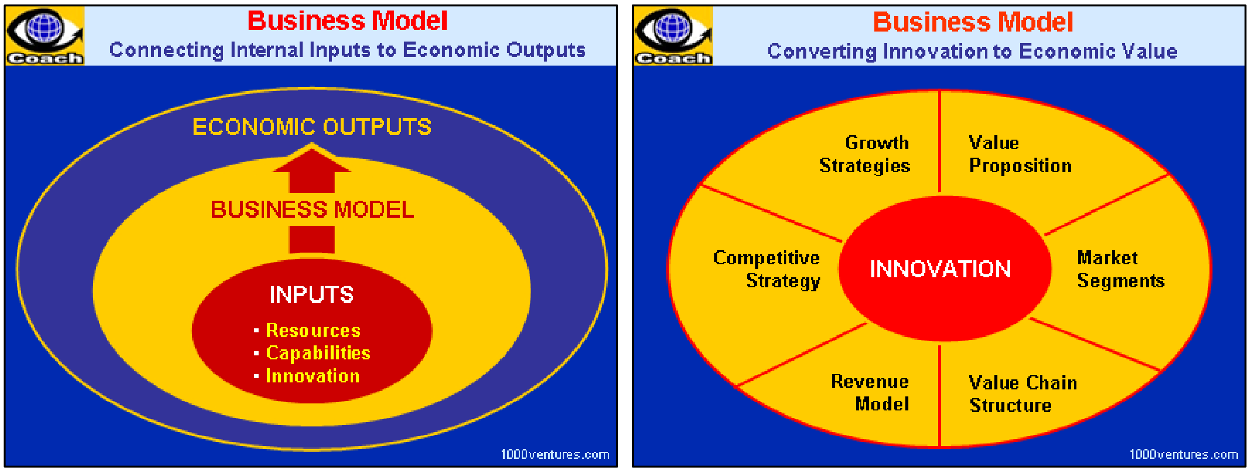


Fig. 1.24: Business Model [622] [623]

- **Product innovation** has been the classical and nowadays reasonably well understood centre of attention. Product development processes and various product-marketing methods (e.g., morphological box) have facilitated the structured design of innovative products. Economies of scale are built into this type of innovation by reusing existing architectures and processes when designing new products. [263]
- **Service Innovation**: Often overlooked but equally important are service innovations; that take the form of new service applications. One reason why service innovations don't attract as much attention as product innovations is that they are often less spectacular and less eye-catching. This probably has something to do with the fact that where innovation is concerned, the public imagination has always tended to identify with inventions, rather than innovation as such. Because of their high novelty value, inventions are usually products….Service innovations typically take the form of a new way of providing a service, often with a novel and very different business model. Occasionally they even take the form of an entirely new service. [307]
  - Has grown in popularity due to the comprehensive digitalization efforts in industries such as government, retail, finance or entertainment. While many lessons can be learnt when services are regarded as products, the close involvement of customers, the ease of global service distribution, service delivery via mobile channels and the long tail in the service development process provide unique challenges and opportunities. [263]
  - Jim Spohrer, director of service research at IBM's Almaden Research Center said that "People have a good idea of what technological innovation is,…,But service innovation is more hidden… The average person knows the story of Thomas Edison, the inventor and innovator who came up with the light bulb. People don't tend to think of the related service innovations—getting light bulbs into houses and schools, setting prices for the electricity services to keep them lit. That's all service innovation." [280]

  - However, most improvements to service activities are **incremental**. Stores stay open longer; product makers establish Web sites with e-commerce functions; airlines, casinos and supermarket chains enhance loyalty card programs. These improvements are useful and indeed necessary, but they are limited in the kind of returns they can produce. Only rarely does a company develop a service that creates an **entirely new market** or so **reshapes a market** that the company enjoys unforeseen profits for a considerable length of time. Market-creating service innovation promises far greater upside potential than imitative or incrementally improved service offerings. Consider, for example, that market creators **Google** (incorporated in 1998) and **eBay Inc.** (started in 1996) have market capitalizations of approximately $110 billion and $60 billion respectively, placing them in the top ranks of U.S. companies. [283]
- **Process Innovation**: If service innovations come second behind product innovations, then process innovations almost certainly come a poor third. And yet process innovations often have an even bigger impact on society than either product or service innovations. Although generally less well known than product innovations, examples of process innovations, including ones that have had a dramatic impact on society as a whole, abound. [307]

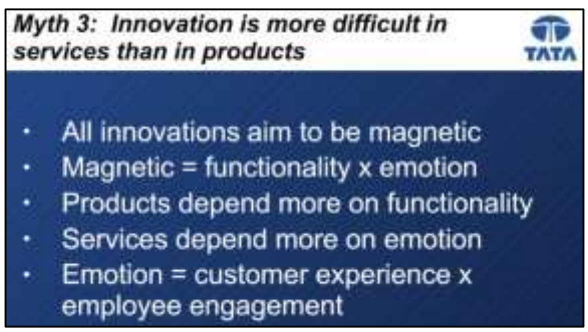
> The humble photocopier, developed by Chester Carlson, may not sound like a spectacular innovation, and yet it had a big impact on the way in which administrative systems in offices are organized. One has only to look at what happens in an office when the photocopier breaks down to see how reliant we are upon it. [307]

> Henry Ford's introduction of the Moving Assembly Line at his new Highland Park plant in Detroit in 1913 resulted in a dramatic reduction in manufacturing effort. Improved productivity on this scale, enabled him to dramatically reduce the price of his Model T car. The price of a Ford Model T which in 1908 was $850, fell to $600 in 1913 and $360 by 1916. [307]

> Today a similar revolution in production is taking place, but this time the revolution is occurring not on the factory floor but in the office. Business-to-business (B2B) Ecommerce is dramatically reducing the need for paperwork and those who process paper, namely administrators. It is no surprise that all sorts of business organizations from airlines to insurance companies offer a discount for buying online. Buying online means less paper and money spent processing paper. One has only to look at the size of the discounts offered to get an idea of the efficiency gains that firms can make. [307]

- **Business Model Innovation** is maybe the most significant of all four types of innovation. Business model innovation is probably the most challenging of the innovation types as it will likely present an organization with major requirements for change. [263] [308]

- Dell and Amazon are good examples, where new processes, not new products, have inserted innovation into the traditional business models of organizations selling books or computers. This demonstrates the transformational power of designing innovative processes (and related services) in markets with matured products. Dell's innovation of a new distribution model by allowing online customization that capitalized on improving internet technology.
- IBM that has managed changes in customer offers from mainframes to personal computers to technology services.
- Apple that has evolved its customer offers of personal computers to music delivery devices and service that ultimately included cellular phones.
- Walmart's fundamental changes to a networked enterprise structure and value chain [263] [308]



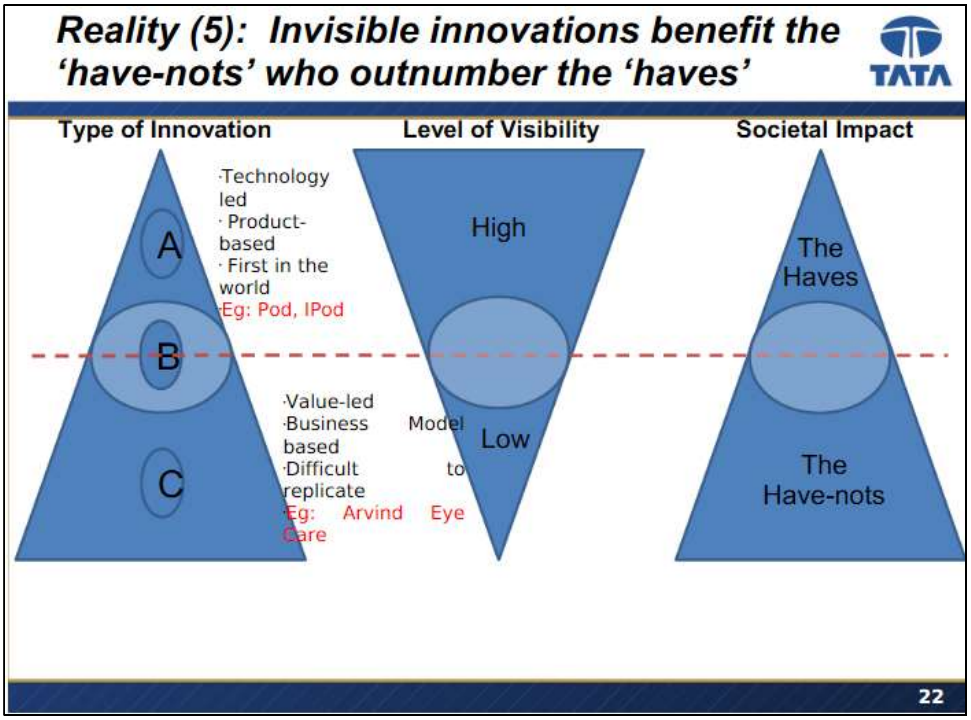


Fig. 1.25: Presentation on Innovation by R. Gopalakrishnan, Director Tata Sons [413]

Service innovation differs from product innovation in important ways.

- First, for labor-intensive, interactive services, the actual providers — the service delivery staff — are part of the customer experience and thus part of the innovation.
- Second, services requiring the physical presence of the customer necessitate "local" decentralized production capacity.
- Third, service innovators usually do not have a tangible product to carry a brand name. [280]

Fig. 1.26: Advantages of Service innovation [282]

As per FICCI report on Innovation (2012) "**Innovations in India had been largely product centered**. Not much thought has been applied to innovating business, marketing, and delivery processes that would give superior benefits to consumers. This focus is now changing. These days, world-class companies such as Microsoft, PepsiCo, IBM, Cisco, Nokia, GE, Xerox, and so on are using India as their research and development (R&D) base to pilot next-generation business models and organizational structures and to develop affordable and sustainable solutions that can then be marketed on a global scale. In doing so, these firms are synergistically integrating their India R&D operations into their global innovation networks. But that is only one part of the story. Innovation in India is largely driven by Indian entrepreneurs…Progress towards promoting innovation in India is significant in terms of ideation; development of solutions; proof of concept; and pilot, production, and commercial launch. However, **India still needs to cultivate innovation as a habit (or attitude)** so that every single individual is responsible for contributing his or her part. An open innovation concept is essential. India needs to prepare itself to work with an open concept in a close collaboration from seeding the idea to rapid prototyping and partnering with customers, research organizations, academic institutes, and so on. To genuinely innovate, companies should invest in an array of skunk-works projects, labs, learning centres, institutes, and other venues. These encourage collective experimentation by creative, innovative people. [404]

1.14.2. Radical, Incremental Innovation, Modular and Architectural Innovations

A useful distinction can be made between **radical innovation** and **incremental innovation**. Radical innovations comprise entirely new products, often undertaken by new entrants with a diversified knowledge base, for example, Minor improvements in existing products and processes constitute incremental innovations, often undertaken by incumbent firms with a specific knowledge base. [164]

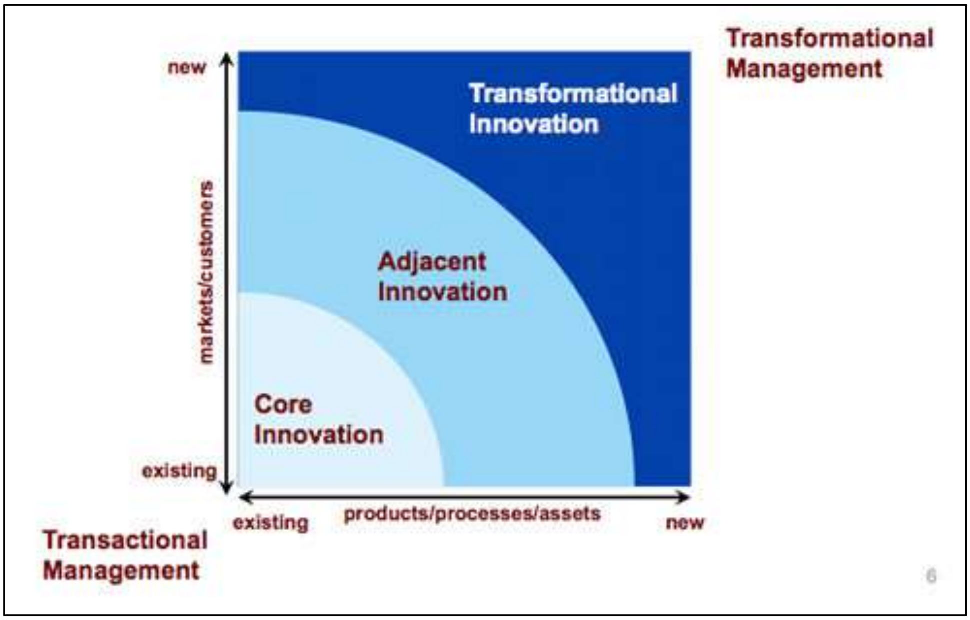


Fig. 1.27: The Innovation-Ambition-Matrix [263]

In 1990, Rebecca M. Henderson from MIT and Kim B. Clark from Harvard University wrote an interesting article, **Architectural Innovation**: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms, which described an innovation typology that was based on an innovation's impact on core design components and/or relationships between them.

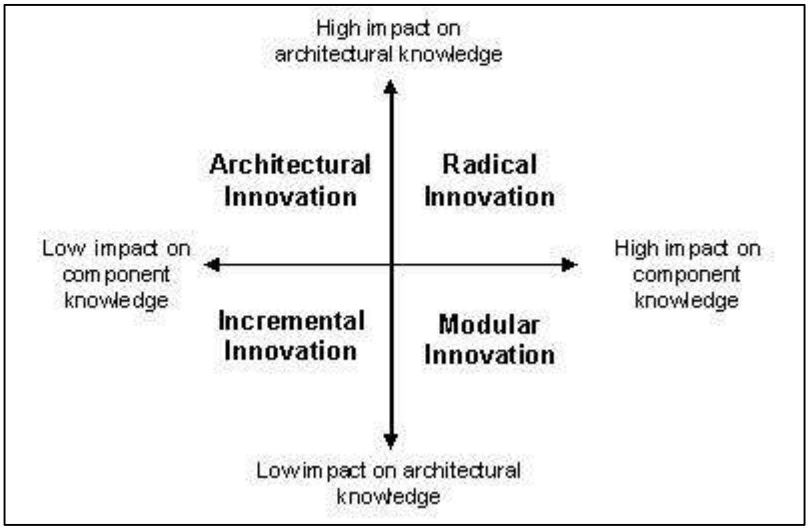


Fig. 1.28: Incremental vs. Modular vs. Architectural vs. Radical Innovation [328] [329]

Henderson and Clark noticed that the Incremental – Radical dichotomy alone was **not enough** to explain what company would be in a better position to innovate and under what circumstances. They started wondering, for instance, why some incumbents would fail to catch something as straight-forward as some incremental innovations, just like **Xerox failed to develop a small plain-paper copier even when it was the leader in xerography technology**. The investigation led them to divide the technological knowledge required to develop new products, and consequently to introduce innovations, along two new dimensions: knowledge of the **components** and knowledge of the linkage between them, called **architectural knowledge**. [328] [329]

- **Incremental innovation** introduces quality improvements in core components. The word renovation would more precisely describe this type of innovation.
- **Modular innovation** may result in the complete redesign of core components, while leaving linkages between the components unchanged.
- **Architectural innovation** changes the nature of interactions between core components, while reinforcing the core design concepts.
- **Radical innovation** introduces a new meaning, potentially a paradigm shift. [328] [329]

1.14.3. Breakthrough, Sustaining, Basic Research and Disruptive Innovations

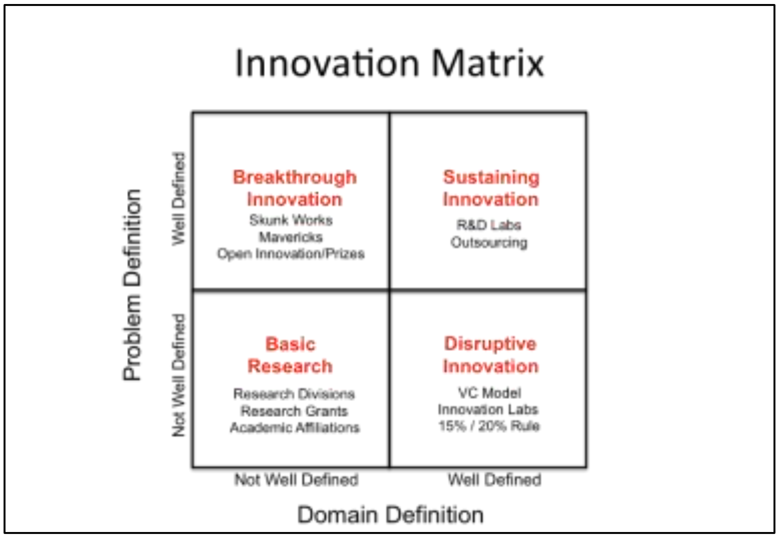


Fig. 1.29: Innovation Matrix [276]

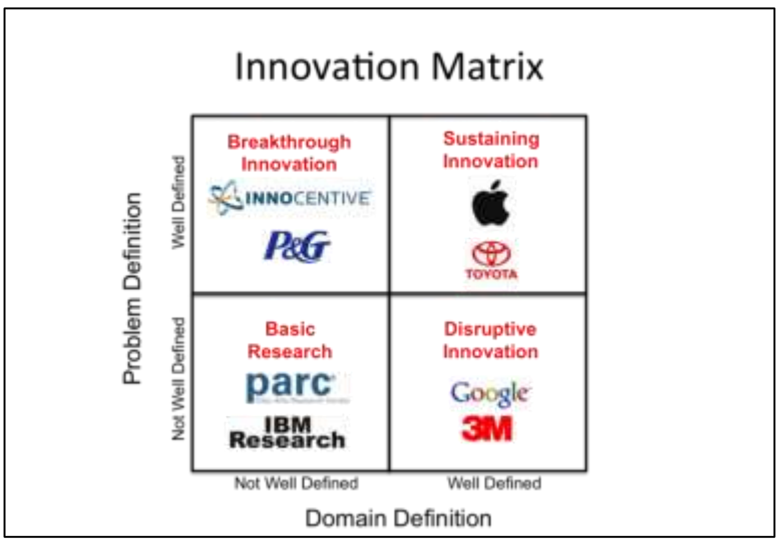


Fig. 1.30: Innovation Matrix with examples [276]

- Basic Research: When you're aim is to discover something truly new, neither the problem nor the domain is well defined. While some organizations are willing to invest in large-scale research divisions, others try to keep on top of cutting edge discoveries through research grants and academic affiliations. Often, the three approaches are combined into a comprehensive program. While most basic research happens in academic institutions, some businesses can excel at it as well. **IBM research is one that truly focuses on pushing the boundaries of science**. In 1993, for example, they accomplished the first quantum teleportation; a technology that isn't likely to result in a product until after 2020. They continue to lead in patents. Xerox's PARC division, on the other hand, shows both the potential and the pitfalls of basic research.

Major innovations such as the Ethernet, the graphical user interface and the mouse were developed there, **but Xerox failed to commercialize them**. They have since spun off the division, which now operates as a high-end research outsourcing contractor. [276]

- Breakthrough Innovation: Sometimes, although the problem is well defined, organizations (or even entire fields of endeavor) can get stuck. For instance, the need to find the structure of DNA was a very well defined problem, but the answer eluded even Linus Pauling, the most talented chemist of the day. **Usually, these types of problems are solved through synthesizing across domains**. For instance, Watson and Crick solved the DNA problem by combining insights from chemistry, biology and X-ray crystallography. In a similar vein, many companies are learning to embrace **open innovation in order to pull in diverse resources**. There are those rare souls who are capable of making breakthroughs, but usually only earlier in their career. However waiting for a maverick genius to come along isn't a viable business model. That's why many firms are turning to open innovation platforms such as Innocentive, which allow outsiders to solve problems that organizations are stuck on. Procter and Gamble has built its own Connect + Develop platform which allows them to benefit from expertise in a variety of domains across the world. [276]
- Sustaining Innovation: Whatever you do, you always want to get better at it. Every year, our cameras produce more pixels, our computers get more powerful and our household products become "new and improved." Large organizations tend to be very good at this type of innovation, because conventional R&D labs and outsourcing are well suited for it. While **everybody agrees that Apple is a superior innovator, the truth is that they rarely produce anything truly new**. They didn't invent the digital music player, the smartphone or even the tablet computer. However, they improve on earlier versions to such an extent that they seem like they're something completely new. In a similar vein, Toyota makes cars just like any others, except better. What both companies have in common is that they are masters at adapting breakthrough innovations for existing markets (it was, after all, Steve Jobs who most benefited from PARC's work). In essence, great sustaining innovators are great marketers. They see a need where no one else does. [276]
- Disruptive Innovation: The most troublesome area is disruptive innovation, because its value isn't always immediately apparent. Notably, Yahoo and Blockbuster had the opportunity to invest in Google and Netflix early on, but missed the opportunity because they didn't see the potential. While every new Apple product turns heads, **when Google comes out with something most people won't even understand what it is much less how they'll make money on it**. From Google Maps to autonomous cars, they manage to fill needs we didn't even know we had. [276]

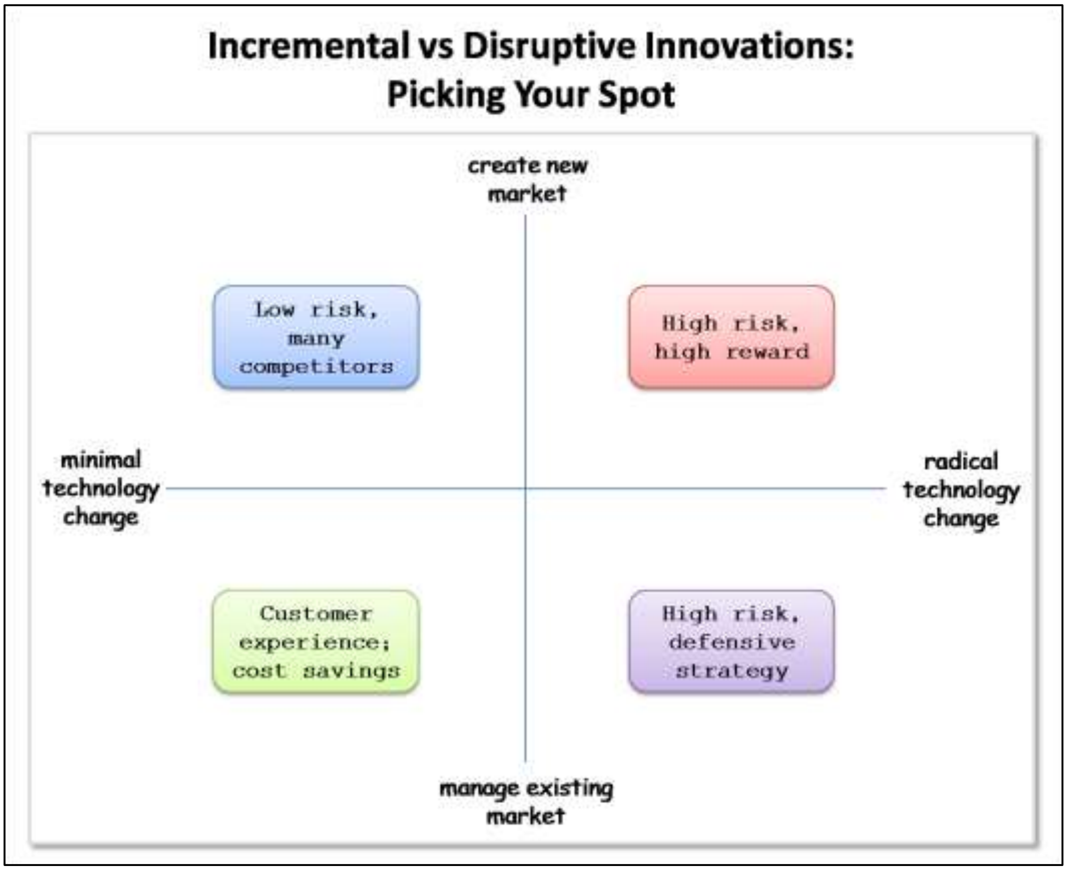


Fig. 1.31: Incremental vs. Disruptive Innovations [330]

1.14.4. Open vs. Closed Innovation

Open Innovation is a term promoted by Henry Chesbrough, a professor and executive director at the Center for Open Innovation at the University of California, Berkeley, in his book "Open Innovation: The new imperative for creating and profiting from technology". "Open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology". [273]

The Closed Innovation Model: Under the concept of innovation that prevailed during most of the 20th century, companies attained competitive advantage by funding large research laboratories that developed technologies that formed the basis of new products that commanded high profit margins. This vertical form of the research meant that companies who could not afford this research were at a disadvantage. [273]

The advantages of Open Innovation are:

- Faster time to market
- Reduced risk of innovation
- Less risk guessing what the market wants
- Let the market / community tell you what they want

- Integrated community innovation
- Innovation can come from anywhere and anyone
- Some of the best ideas are outside of your organization
- Some of the best solutions reside outside of your organization
- Lower R&D and operating costs
- Supplement to internal R&D
- Tapping into the virtual R&D community
- Creating brand evangelists out of your community
- Shared IP can create a formidable barrier to entry [273]

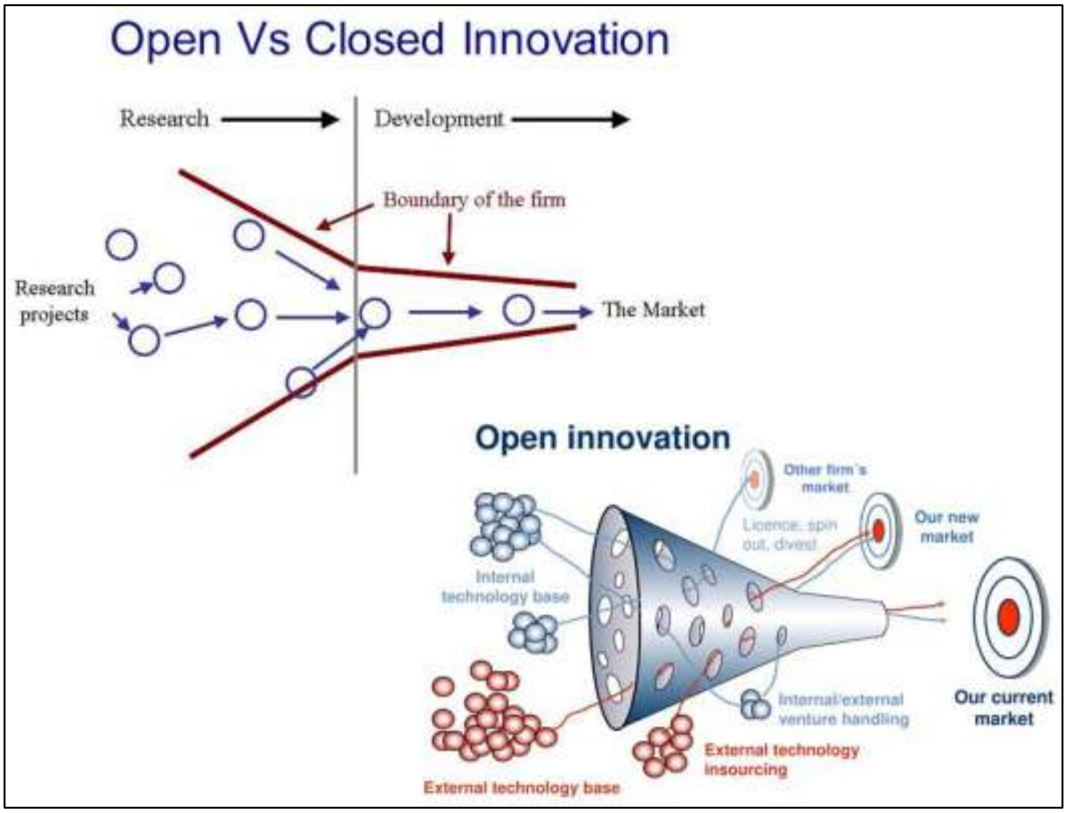


Fig. 1.32: Open vs. Closed Innovation [273] [278]

Closed innovation	Open innovation
All the best people are working for us	Not all the best people are working for us . We must work with clever people within and outside our company.
R&D creates profit only when we invent, develop and market everything ourselves.	External R&D can create remarkable value; to employ it, we need absorption capacity, often as internal R&D.
If we develop the product ourselves, we will be the first on the market.	R&D can create profit even if we do not initialize and perform it ourselves.
Winner is who gets the innovation to the market first.	To develop better business model is more important than to be the first in the market.
We will win if we develop most of the ideas (an the best of them).	We will win if we make best use of internal and external ideas.

We must have our intellectual property under control so that our competitors can make advantage of it.	We must be able to profit from others using our intellectual property and we must license the intellectual property if it supports our business model.
Examples: nuclear industry, mainframe computers	Examples : PC, movies
Mostly internal ideas	Many external ideas
Low workforce mobility	High workforce mobility
Low role of the venture capital	Active venture capital
Few new businesses, weak ones	Many new businesses
Universities are not important as the sources of ideas	Universities are not important as the sources of ideas and people

Table. 1.2: Open vs. Closed Innovation [273] [278]

1.14.5. Inclusive Innovation

"**Inclusive innovation should thus involve and benefit people at the bottom of the pyramid**." Anil Kakodkar Chairman, Research Advisory Council, JNNSM at Department of Atomic Energy [240]

Innovation is being seen as a means of creating sustainable and cost effective solutions for people at the bottom of the pyramid, and is being viewed as an important strategy for inclusive growth in developing economies. [45] [46]

Why is developing India Embracing Inclusive Growth: The attention to and recognition of the relevance and importance of inclusive growth in developing Asia have been triggered by a rising concern that the benefits of spectacular economic growth have not been equitably shared. [242]

There has been a lagged, though parallel growth in academic interest, with labels attached to this phenomenon including

- Inclusive Innovation
- Pro-Poor Innovation
- Below-The-Radar Innovation
- Grassroots Innovation
- BoP (base of the pyramid) Innovation [242]

At root inclusive innovation takes a different view of development from conventional views of innovation (IDRC 2011): "**Conventional views of innovation (often implicitly) understand development as generalized economic growth**. By contrast, **inclusive innovation explicitly conceives development in terms of active inclusion of those who are excluded from the mainstream of development**. Differing in its foundational view of development, inclusive innovation therefore refers to the inclusion within some aspect of innovation of groups who are currently marginalized". [242]

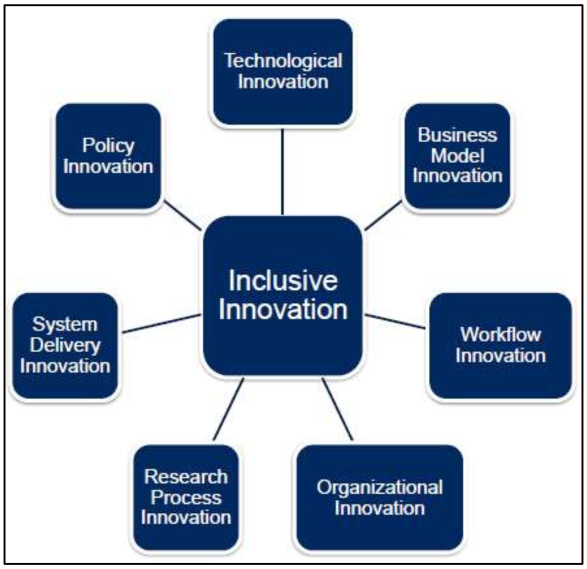


Fig. 1.33: Inclusive Innovation [239]

Fig. 1.34: Inclusive vs. Traditional Innovation [241]

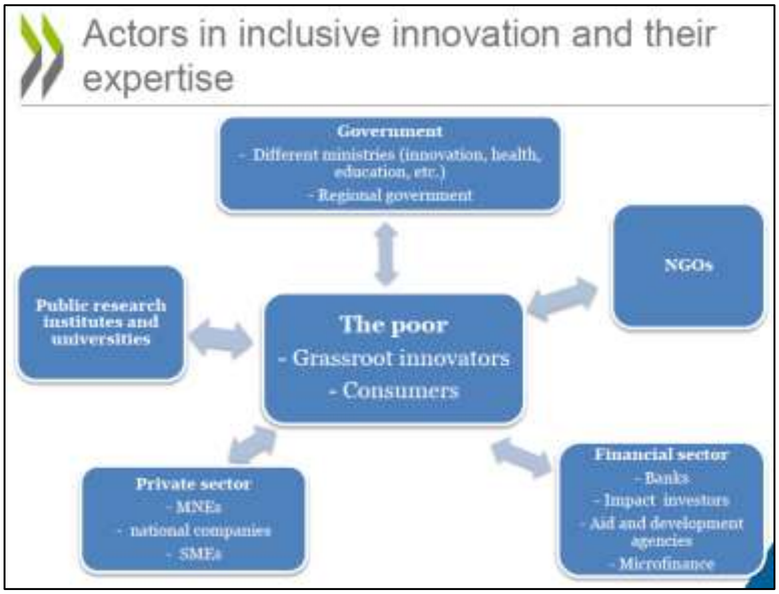


Fig. 1.35: Actors in Inclusive Innovation [241]

1.14.6. Frugal Innovation

Frugal Innovation is about doing more with less. Entrepreneurs and innovators in emerging markets have to devise low cost strategies to either tap or circumvent institutional complexities and resource limitations to innovate, develop and deliver products and services to low income users with little purchasing power.

- The Chinese company BYD has developed a very low-cost method for producing lithium-ion batteries. The company has reduced the cost of a battery from US$40 to less than US$5.
- China's Zhongxing Medical has developed an X-ray machine that can produce digital images directly. It costs just one-tenth of the price Western multinationals charge for their specialized digital X-ray machines.
- GE, the US industrial giant, has produced a handheld electrocardiogram machine that costs a fraction of traditional EKGs. This innovative device has brought down the cost of testing a patient to just US$1.
- The Indian industrial group Godrej & Boyce has developed a US$69 fridge that runs on batteries, called the ChotuKool.
- India's Tata Chemicals has developed a water purifier that uses a combination of rice husks and silver nanotechnology to filter out bacteria. The Tata Swach costs just US$20.
- Bharti Airtel, an Indian telecom company, has turned itself into one of the world's most cost-efficient mobile service provider by creating innovative partnerships with suppliers and by sharing the costs of infrastructure with competitors.
- The Finnish telecom company Nokia has produced a handset that costs less than US$20. Its features include a dust-resistant case and a contacts book that can be used by up to five users, because many low-income customers share a phone. [416]

1.14.7. Reverse Innovation

Vijay Govindarajan, Professor of International Business, Dartmouth College, USA stated that "Today, the locus of innovation in the global economy is shifting. Many multinationals are moving away from the traditional model of 'glocalisation,' where they develop products in their wealthy developed nation and distribute them worldwide, in favor of a model in which **they do just the reverse**: create products for developing nations first and then market them to developed nations. I first used the term "**Reverse Innovation**" to describe this phenomenon in a 2009 in Harvard Business Review article… In the paper, we highlighted **GE's** success developing a **compact ultrasound machine** for China's poorly funded, low-tech hospitals and rural clinics. Unlike GE's high-end, high-priced models aimed at markets in developed countries, these machines were low-cost, portable, and simple to use. They have since been adopted in other parts of the world, including the United States, where they form a lucrative product line for the company." [484]

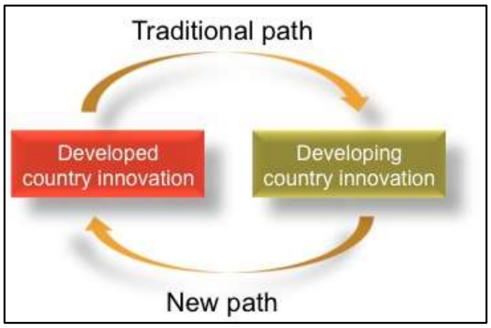


Fig. 1.36: Reverse Innovation [485]

Nestle's Maggi brand – Low-cost, low-fat dried noodles developed for rural India and Pakistan found a market in Australia and New Zealand as a healthy and budget-friendly alternative. [486]

1.14.8. Proactive, Active, Reactive and Passive Innovations

Fig. 1.37: Proactive, Active, Reactive and Passive Innovations [319]

1.14.9. Marketing and Organizational Innovation

- Marketing innovation: implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing.
- Organizational innovation: implementation of a new organizational method in the firm's business practices, workplace organization or external relations.

Fig. 1.38: Systemic Approach to Innovation [649] [650]

1.15. Examples of Innovation: 20th Century & 21st Century

Examples of Innovation: 20th Century

1. Electrification
2. Automobile
3. Airplane
4. Water supply and distribution
5. Electronics
6. Radio and television
7. Agricultural mechanization
8. Computers
9. Telephone
10. Air conditioning/refrigeration
11. Interstate highways
12. Space flight
13. Internet
14. Imaging
15. Household appliances
16. Health technologies
17. Petrochemical technology
18. Laser and fiber optics

19. Nuclear technologies
20. High-performance materials [279]

Examples of Innovation: 21st Century

1. Energy conservation
2. Resource protection
3. Food and water production and distribution
4. Waste management
5. Education and learning
6. Medicine and prolonging life
7. Security and counter-terrorism
8. New technology
9. Genetics and cloning
10. Global communication
11. Traffic and population logistics
12. Knowledge sharing
13. Integrated electronic environment
14. Globalization
15. AI, interfaces and robotics
16. Weather prediction and control
17. Sustainable development
18. Entertainment
19. Space exploration
20. "Virtualization" and VR
21. Preservation of history
22. Preservation of species
23. Global Positioning Systems
24. Digital cameras (1975) [279]

SN	Important Innovations
1.	3D Printing
2.	Airplane
3.	Amazon’s Kindle
4.	Automated Teller Machine (ATM)
5.	Automobile: Electric Car
6.	Bar codes and scanners
7.	Bio fuels
8.	Birth-Control Pill
9.	Communications Satellite
10.	Computer Mouse
11.	Cordless Tools
12.	Digital photography / videography
13.	DNA Fingerprinting
14.	DNA testing and sequencing / human genome mapping
15.	E-mail
16.	Fiber optics
17.	Flash memory
18.	Genetically modified plants
19.	Google Maps

20.	GPS Devices
21.	Graphical User Interface (GUI)
22.	Industrial Robot
23.	Internet, broadband, www (browser and html)
24.	Jet Airliner
25.	LASER Instruments
26.	Light-emitting diodes, LED Light Bulbs
27.	Liquid crystal display (LCD)
28.	Magnetic Resonance Imaging (MRI)
29.	Microprocessors
30.	Microwave Oven
31.	Mobile phones
32.	MP3 Players
33.	Non-invasive laser /robotic surgery (laparoscopy)
34.	Nuclear power
35.	PC/laptop computers
36.	Photovoltaic solar energy
37.	Range of Electronics Kitchen appliances
38.	RFID and applications
39.	Rocket & Space Technology
40.	Satellite navigation
41.	Smart Phone
42.	Social networking via the Internet
43.	Software
44.	Touch Screen Devices
45.	Unmanned Aerial Vehicles
46.	Vacuum Cleaner
47.	Various sensors like Smoke Detector, Temperature detector etc.
48.	Video Games
49.	Wearable Computers
50.	Wi-Fi Instruments

Table 1.3: Important Innovations

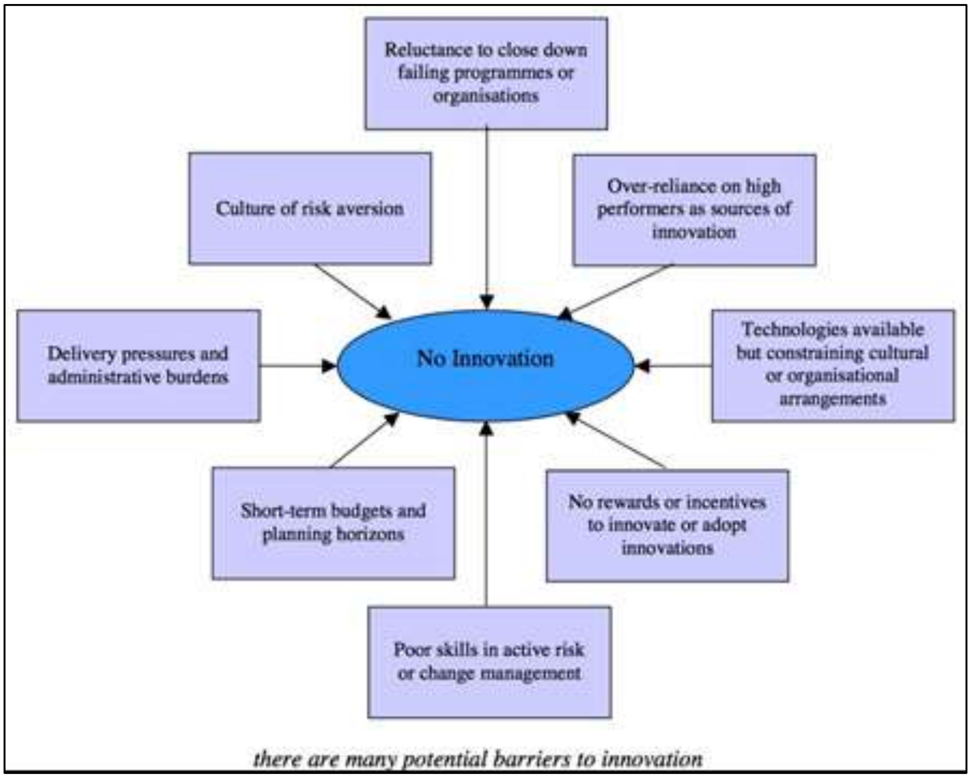
1.16. Barriers of Innovation

According to National Knowledge Commission (NKC) the barriers of innovation in India are

- External
  - Skill shortage due to the lack of emphasis on industrial Innovation, problem-solving, design, experimentation, etc. in the education curricula
  - Lack of effective collaboration with research in universities and R&D institutions, excessive government regulation as well as insufficient pricing power to derive value from Innovations
- Internal
  - The most important internal barriers as perceived by large firms are lack of organizational focus on Innovation as a strategy for growth and competitiveness; inefficient knowledge management systems within the company; and poor understanding of customer needs and market dynamics.

- For SMEs, prominent internal barriers are skill shortages due to lack of effective in-house training programmes; inability to move beyond the first successful Innovation and develop a sustainable model for continuous Innovation; as well as poor understanding of customer needs and market dynamics. [215]

The following diagram shows the barriers of innovation.



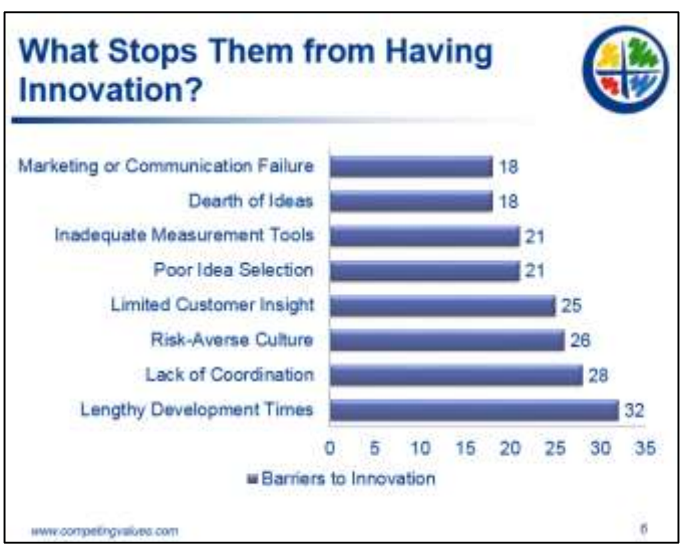


Fig. 1.39: The Barriers of Innovation (Geoff Mulgan and David Albury's diagram how public bodies do not innovate) [59] [321]

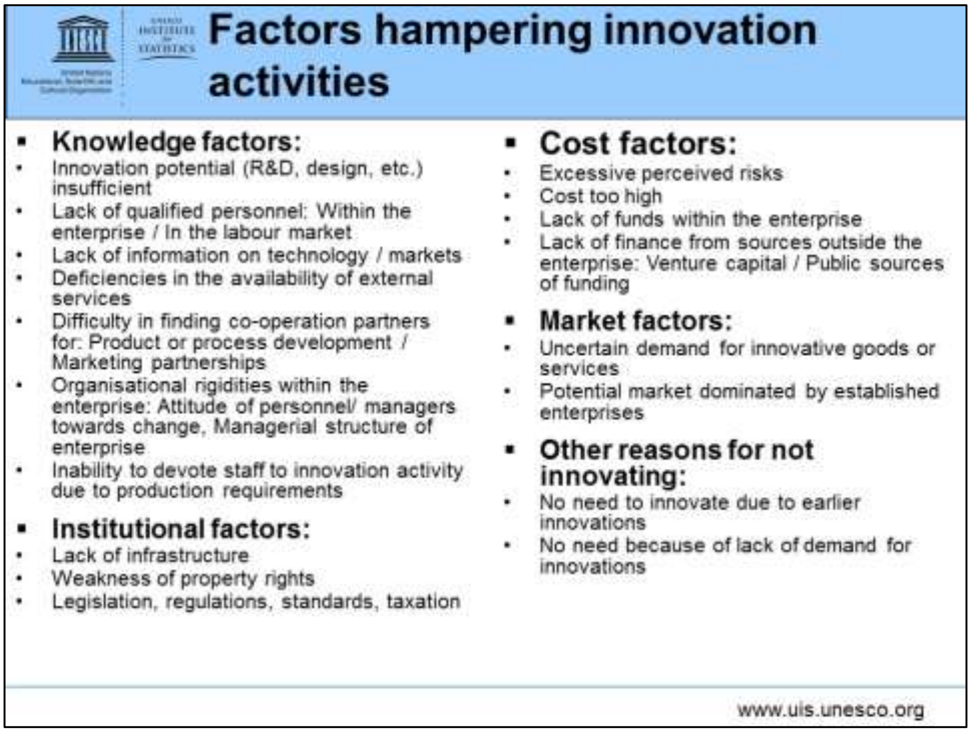


Fig. 1.40: Factor Hampering Innovation [490]

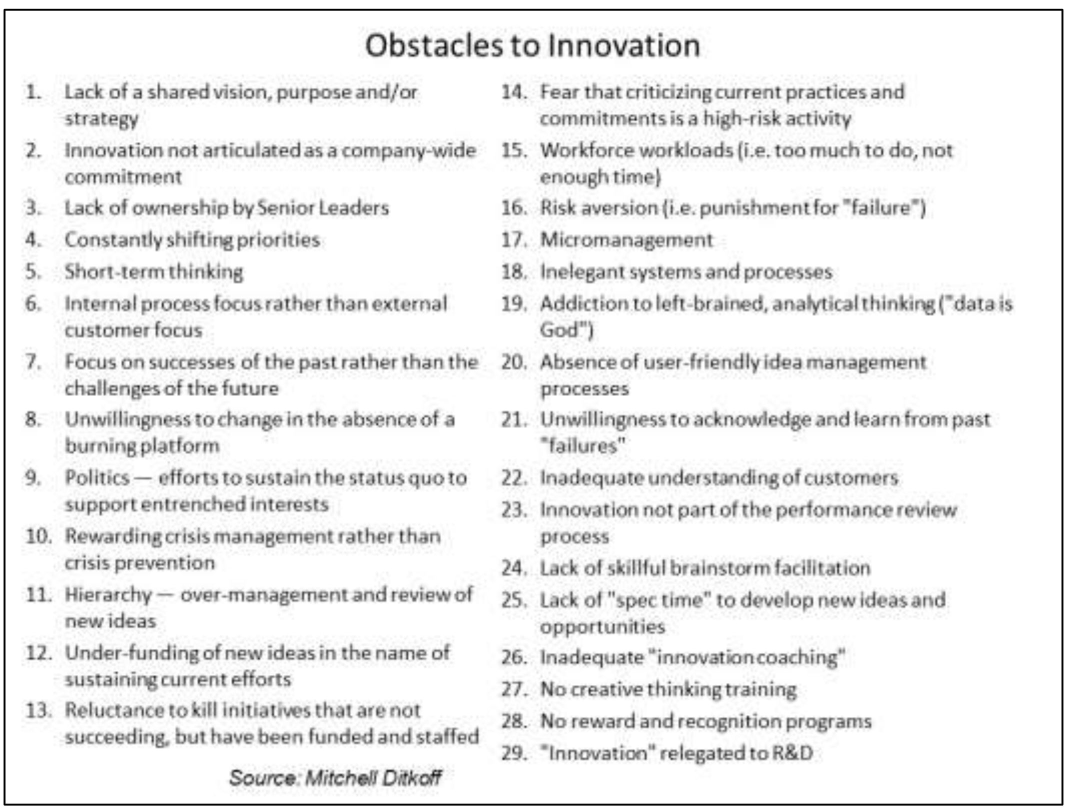


Fig. 1.41: Obstacles to Innovation [649]

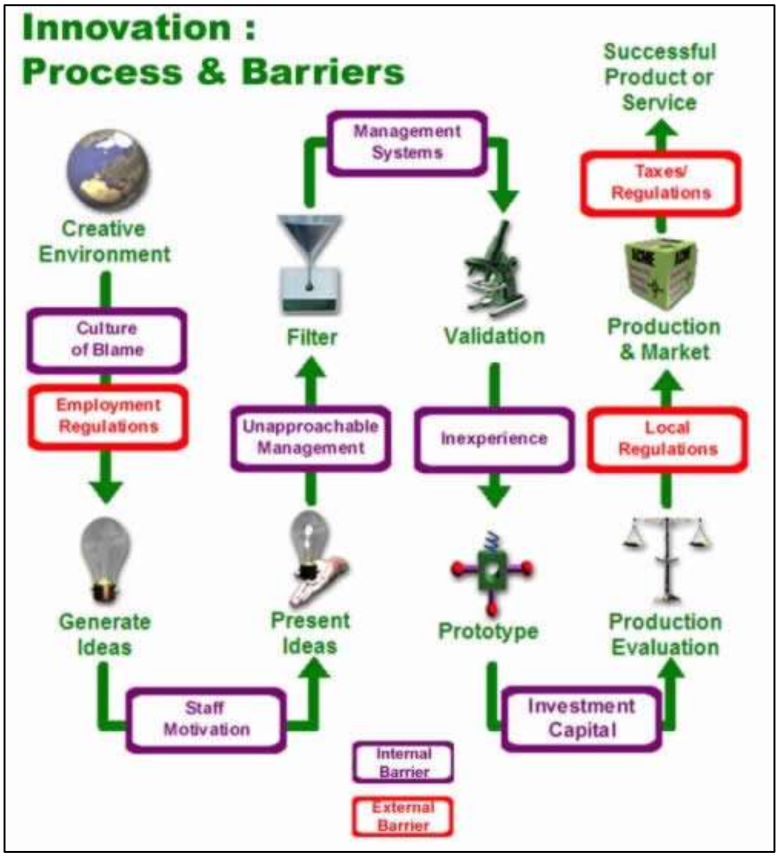


Fig. 1.42: Innovation Process & Barriers: Internal Barriers and External Barriers [16]

1.17. Innovation: Unpredictable & Time Taking Process

Uncertainties are still at the heart of innovative activities. The basic fact of life here is that it is extremely difficult to forecast how the market will respond to the introduction of some new technology. Let’s consider few examples.

Television: In 1939 the New York Times reported on the success of recent experiments that obviously foretold the arrival of a potentially fascinating new product: television. But the New York Times did not think that television had much of a future – at least not in the United States. This most prominent and influential of all American newspapers solemnly declared: “Television will never be a serious competitor for radio, because people must sit and keep their eyes glued on a screen; the average American family hasn’t time for it. [251]

Airplane: The airplane first left the ground in 1903. The initial flight was less than the length of a football field, and the airplane was not an innovation of great commercial significance until the late 1930s. Why not? It took fully one-third of a century because many thousands of design improvements were necessary before airplanes became sufficiently safe and reliable to become widely used by the general public. [251]

Mobile Phones: In 1983, when AT&T was being divested in an anti-trust suit, it was considering whether it should attempt to retain the frequencies that would be essential for the operation of mobile phones. AT&T therefore hired one of America's best-known consulting firms to forecast the likely number of American subscribers for mobile phones by the year 1999. The forecast that was eventually given to AT&T was that there might be as many as one million subscribers to mobile phones in 1999. In fact, the number of subscribers passed the 70 million mark in that year! The situation with respect to the mobile phone in 1983 was, in some important respects, very similar. Those phones were primitive. They were so heavy and bulky that they hardly deserved to have been called "mobile." The quality of voice transmission was extremely poor. And, most important, the original mobile phones of 1983 sold for around USD 3 000, compared with much less than USD 100 in the United States today. [251]

Computer: The first digital, electronic computer was operating at the University of Pennsylvania, school of engineering at the end of 1945, and a number of firms were already engaged in the manufacture and sale of computers by 1950. And yet, as late as 1956 Howard Aiken, a brilliant physics instructor at Harvard and one of the great pioneers in computer development, continued to conceive of the computer as no more than a highly specialized scientific instrument. In 1956, in testifying before a congressional committee he was still, obviously, thinking of the computer as no more than an instrument suitable for only a narrow range of scientific research purposes. Aiken stated in that congressional testimony: "...if it should ever turn out that the basic logics of a machine designed for the numerical solution of differential equations coincide with the logics of a machine intended to make bills for a department store, I would regard this as the most amazing coincidence that I have ever encountered." [251]

1.18. Measuring Innovation or Innovation Indicators or Innovation Metrics

One can measure innovation rate through number of innovation indicators like

- R&D expenditure in relation to competitors
- R&D costs as % of revenue
- Patents: patents per employee
- Copyrights
- Trademarks
- Research Publications
- Innovation awards
- PhD thesis
- Attraction of technology-based investments

- Start-ups creation
- In case of University, the industry funding can be a measure of innovation etc.
- New Product share of total profits; Time to Market, Break Even Time, etc.
- Innovation costs dedicated to core business, new business and early trials, etc.

The degree of Novelty can be:

- Diffusion: Diffusion is the way in which innovations spread, through market or non-market channels, from their first worldwide implementation to different consumers, countries, regions, sectors, markets, and firms. Without diffusion, an innovation will have no economic impact. The minimum entry for a change in a firm's products or functions to be considered as an innovation is that it must be new (or significantly improved) to the firm.
- New to the firm: A product, process, marketing method, or organizational method can already have been implemented by other firms, but if it is new to the firm (or in case of products and processes: significantly improved), then it is an innovation for that firm.
- New to the market: the firm is the first to introduce the innovation onto its market. The market is defined as the firm and its competitors. The geographical scope is subject to the firm's own view of its operating market and thus can include both domestic and international firms.
- New to the world: The firm is the first to introduce the innovation for all markets and industries, domestic and international. It implies a qualitatively greater degree of novelty than new to the market.
- Disruptive innovations: An innovation that has a significant impact on a market and on the economic activity of firms in that market. Focuses on the impact of innovations as opposed to their novelty. These impacts can, for example, change the structure of the market, create new markets, or render existing products obsolete. However, it might not be apparent whether an innovation is disruptive until long after the innovation has been introduced.

1.19. Interesting History of Innovation in Business

While innovation has existed as long as the species has, early innovations penetrated society and became established more slowly. For example, printing technology, various transportation innovations, and the use of gunpowder took centuries to reach most levels of society and become part of everyday life. [315]

The penetration and acceptance of various innovations began to accelerate with the gradual collaboration and cooperation of science and assorted crafts and industries, especially in the 19th century. The partnership between science and industry allowed scientists to produce practical, reproducible technologies, which businesses could reasonably afford. Because of this collaboration, innovation grew quickly. **Despite the partnership, however, science and businesses still remained separate entities**. Researchers worked either independently or as members of companies that specialized in developing, producing, and marketing innovations during this period. Consequently, **many of these innovations failed to make it to the market**. [315]

Companies, however—especially **power, chemical, and communications companies**—began creating in-house research and development divisions early in the 20th century. In addition, **they enhanced and marketed the innovations of others, breaking down the barrier between innovator and company**. As a result, companies, not individuals, began controlling the patents to new inventions. Furthermore, **teams of company researchers**, not lone inventors, **became the primary innovators**. [315]

1.20. Possible Benefits of Innovation

As per the FICCI MSME Summit 2012 report on "Innovation & Clusters" the objectives of Innovating companies for carrying out innovations could be:

- Improve product quality
- Learn about new technology
- Reduce production cost
- Reduce labor costs
- Extend product range
- Improve cycle time
- Increase market share
- Improve production flexibility
- Open up new markets
- Reduce energy consumption
- Fulfill regulations& standard
- Comply with domestic regulation
- Reduce environment effects
- Improve work conditions for employees [404]

SN	Possible Benefits of Innovations
1.	Further innovation
2.	Improve working conditions
3.	Improve Product Quality
4.	Improvements in quality of the workforce
5.	Improvements infrastructure,
6.	Increase income avenues, Profit/Margins increase
7.	Increase of competitive advantage
8.	Increase in investment
9.	Innovation companies generally do not need to do an excess amount of advertising or branding to capture their target market. Instead, their name alone carries considerable weight in their industry and people await their products to hit the market
10.	Maintain efficient operating systems
11.	Making the supply chain more responsive, flexible and efficient. Supply chain innovation can be used to reduce costs, offer better assortment of customer centric products, decreasing time to market and driving growth.
12.	Markets development, Create new markets
13.	More responsive customer service
14.	Opportunity to build early customer loyalty
15.	Personalized services
16.	Positive changes in competitiveness

17.	Positive changes in efficiency,
18.	Positive changes in market share
19.	Positive changes in productivity
20.	Positive changes in quality
21.	Product differentiation
22.	Product diversification, extend product range
23.	Reduce environmental damage
24.	Reduce total cost of production
25.	Satisfying consumer needs
26.	Securing a market strategic position
27.	Use of economies of scale
28.	Use of new business opportunities

Table 1.4: Benefits of Innovation

1.21. Innovation Adoption Lifecycle: Innovators to Laggards

The Everett Rogers Innovation Adoption Lifecycle classify people from Innovators to Laggards as follows:

- Innovators - people who enjoy everything new, pretty brave to try unready products or ideas and influence them with feedback or contribution.
- Early adopters - thought-leaders who are happy to try new products or ways of work to share their early feedback.
- Early majority - pragmatic people who often accept the changes faster than others and get early benefits or competitive advantage.
- Late majority - people who start using new products or ideas only when majority already uses it and shared positive feedback.
- Laggards - conservative people keeping "old way of work" while it is physically possible, very critical to new ideas until they are widely accepted. [372]

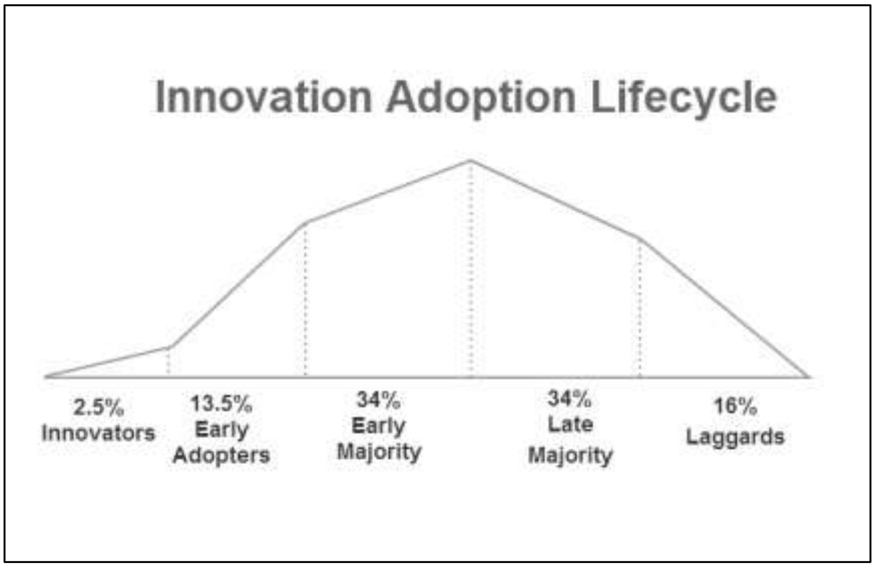


Fig. 1.43: Innovation Adoption Life Cycle [268] [372]

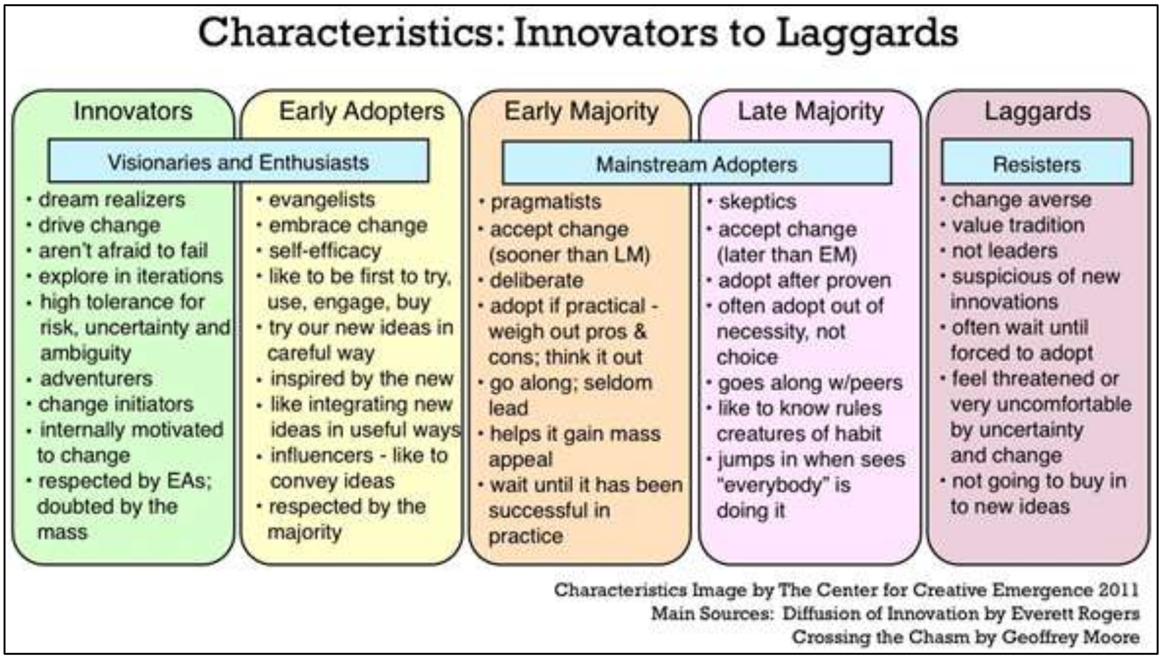


Fig. 1.44: Characteristics of Innovators and Laggards [268] [372]

1.22. Reasons for Innovation Failure

Anyone who works in innovation knows that failure is an inherent part of the process of coming up with something new. What matters is not that you sometimes fail — because you inevitably will — but rather how you respond to that failure and whether you learn from it. [364]

Tim Kastelle, who co-writes the Innovation Leadership Network blog and is a member of the Technology & Innovation Management Centre in the School of Business at the University of Queensland has given hierarchy of failure:

- System failure (the collapse of communism)
- System component failure (stock market crashes)
- Major firm failure (Enron going out of business)
- Start-up failure (pets.com going out of business)
- Product failure (New Coke tanking)
- Idea failure (Apple Navigator prototyped but never launched) [364]

Here are the top ten reasons for innovation failure:

1. Not creating a culture that supports innovation
2. Not getting buy-in and ownership from business unit managers
3. Not having a widely understood, system-wide process
4. Not allocating resources to the process
5. Not tying projects to company strategy
6. Not spending enough time and energy on the fuzzy front-end

7. Not building sufficient diversity into the process
8. Not developing criteria and metrics in advance
9. Not training and coaching innovation teams
10. Not having an idea management system [365]

Top four reasons for product innovation fails:

- The customer does not exist
- There was no value proposition
- Product didn't work
- The path to Market was not clear [366]

Ten reasons why companies fail at business model innovation (Please refer the article for details)

- CEOs don't really want a new business model
- Business model innovation will be the next CEO's problem
- Product is king. Nothing else matters
- Information technology is only about keeping the trains moving and lowering costs
- Cannibalization is off the table
- Nowhere near enough connecting with unusual suspects
- Line executives hold your pay card
- Great idea, what's the ROI?
- They shoot business model innovators, don't they?
- You want to experiment in the real world, are you crazy? [367]

According to surveys by BCG the root causes of Innovation Failure are:

- Lengthy development times
- A risk-adverse culture
- Difficulty selecting the right ideas to commercialize
- Lack of internal and international coordination
- Poor enforcement of time lines & milestones
- Limited measures and metrics to understand performance
- A lack of organizational alignment
- Dissatisfied with return on spending
- Learning to balance risks
- Focusing on time frames more
- Seeing returns across the portfolio of projects
- Earmarking sufficient funds
- Partnering effectively with suppliers and others
- Fostering a climate of innovation that promotes.
- Deepen the understanding of customers
- Moving quickly
- Enforcing time lines and milestones
- Balancing risks and returns across the portfolio
- Obtaining input from across divisions and geographical areas
- Securing early commercial involvement
- Earmarking sufficient funds and appropriate resources

- Providing strong support to the project teams
- Idea selection (mainly technology and telecoms)
- This lack of clear insight into customers (manufacturing)
- A shortage of great ideas (consumer products)
- Inability to get across, market and publicize innovation (Auto)
- Moving ideas to cash
- Time-to-market, time to volume [368]

List of Reasons Why Most Corporate Innovation Initiatives Fail:

1. "Innovation" framed as an initiative, not the normal way of doing business
2. Absence of a clear definition of what "innovation" really means
3. Innovation not linked to company's existing vision or strategy
4. No sense of urgency
5. Workforce is suffering from "initiative fatigue"
6. CEO does not fully embrace the effort
7. No compelling vision or reason to innovate
8. Senior Team not aligned
9. Key players don't have the time to focus on innovation
10. Innovation champions are not empowered
11. Decision making processes are non-existent or fuzzy
12. Lack of trust
13. Risk averse culture
14. Overemphasis on cost cutting or incremental improvement
15. Workforce ruled by past assumptions and old mental models
16. No process in place for funding new projects
17. Not enough pilot programs in motion
18. Senior Team not walking the talk
19. No company-wide process for managing ideas
20. Too many turf wars. Too many silos.
21. Analysis paralysis
22. Reluctance to cannibalize existing products and services
23. NIH (not invented here) syndrome
24. Funky channels of communication
25. No intrinsic motivation to innovate
26. Unclear gates for evaluating progress
27. Mind numbing bureaucracy
28. Unclear idea pitching processes
29. Lack of clearly defined innovation metrics
30. No accountability for results
31. No way to celebrate quick wins
32. Poorly facilitated meetings
33. No training to unleash individual or team creativity
34. Voo doo evaluation of ideas
35. Inadequate sharing of best practices
36. Lack of teamwork and collaboration
37. Unclear strategy for sustaining the effort

38. Innovation Teams meet too infrequently
39. Middle managers not on board
40. Ineffective roll out of the effort to the workforce
41. Lack of tools and techniques to help people generate new ideas
42. Innovation initiative perceived as another "flavor of the month"
43. Individuals don't understand how to be a part of the effort
44. Diverse inputs or conflicting opinions not honored
45. Imbalance of left-brain and right brain thinking
46. Low morale
47. Over-reliance on technology
48. Failure to secure sustained funding
49. Unrealistic time frames
50. Failure to consider issues associated with scaling up
51. Inability to attract talent to risky new ventures
52. Failure to consider commercialization issues
53. No rewards or recognition program in place
54. No processes in place to get fast feedback
55. Inadequate sense of what your customers really want or need
56. Company hiring process screens out potential innovators [369]

1.23. Business Sector and Social Sector Innovations

R Gopalakrishnan, Director, Tata Sons stated that “No matter how much private capital companies suggest that their managements are patient and persistent, it is a reality that their leadership has to consider the bottom line and shareholder value. This places some inevitable limitations. That is why long gestation innovations with unclear commercial returns are very often funded, and even implemented, by public agencies and universities: super computers, space and defense-related technologies, and basic life sciences research. **This created a divide between business sector and social sector innovations.**” [409]

1.24. “I” Factor of Innovation: Credit Goes to “Innovator, who made it available to public”

R Gopalakrishnan, Director, Tata Sons stated that “Whom should history credit with the path-breaking innovations that take place? Should it be the one who conceptualized it and created prototypes or should it be the one who commercialized the innovation for general use and patented it? In both cases, considerable effort and intellect is required, but eventually the world generally remembers and applauds the one who is the face of the innovation and made it available for public use. The world associates Apple Computers solely with Steve Jobs, but the great contributions of Steve Wozniak are less known. Academics cover the achievements and contributions of Thomas Edison in providing mankind with electricity and the first incandescent light bulb, yet there is so much of contributions of Volta, Ampere, Oersted, Ohm, Galvani, Franklin, Maxwell and Faraday that underpin Edison's work." [411]

1.25. Mindfulness, Meditation & Innovation

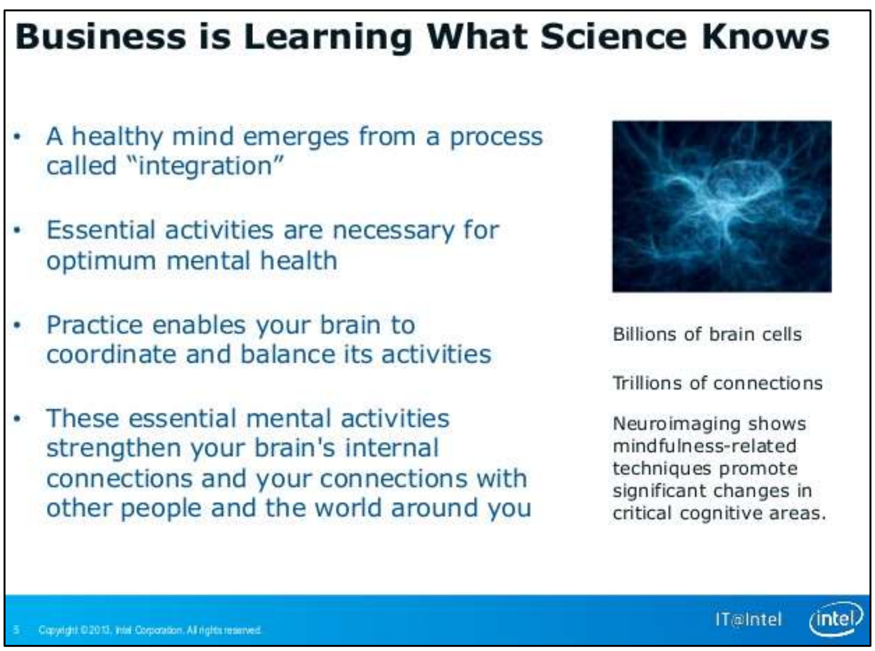
Why on earth are many of the world's most powerful technology companies, including **Google**, showing a special interest in an 87-year-old Vietnamese Zen Buddhist monk? Google has asked the Buddhist monk to talk on the subject of intention, **innovation** and insight, which he says can all benefit from the practice of mindfulness. [681]

Fig. 1.45: Zen Master Thich Nhat Hanh, visited Google campus [681]

Fig. 1.46: Companies that promote Meditation or Mindfulness [501] [502] [503]

In the interview by "**Knowledge at Wharton**", Mandar Apte, Chemical Engineer at Shell stated that "Yes, there is definitely a link. From my perspective, the link is that we're all busy; we're all racing to solve challenges. **As for innovation, you know, it's all about thinking of new things**. One has to learn how to drop the old habits, the old ideas, the old concepts and it's like taking a pause from the business of today, a gap in your mind from the train of thoughts. That's what meditation allows you. It gives you tools and techniques to pause. And silence is the mother of creativity. So, if you can invoke that space of silence within yourself — through any means — it need not be through meditative practice — it could be any other means that anybody chooses to adopt. That's the first step. The second step involves social processes and interpersonal skills. If you can invoke that quality of compassion or empathy in yourself, where you are not judging yourself, you're not criticizing yourself, nor are you judging somebody else, then I think there is a space for insights to be created. These qualities are crucial for grooming your own innovative skills and nourishing the innovation culture in an organization." [500]

For people who find it hard to enter an imaginative state, consider meditation. An expert can help people clear their minds of distractions and then plant an image to help spark the imagination. This is something that we have done at the Brussels Imagination Club and the results have been impressive. [499]



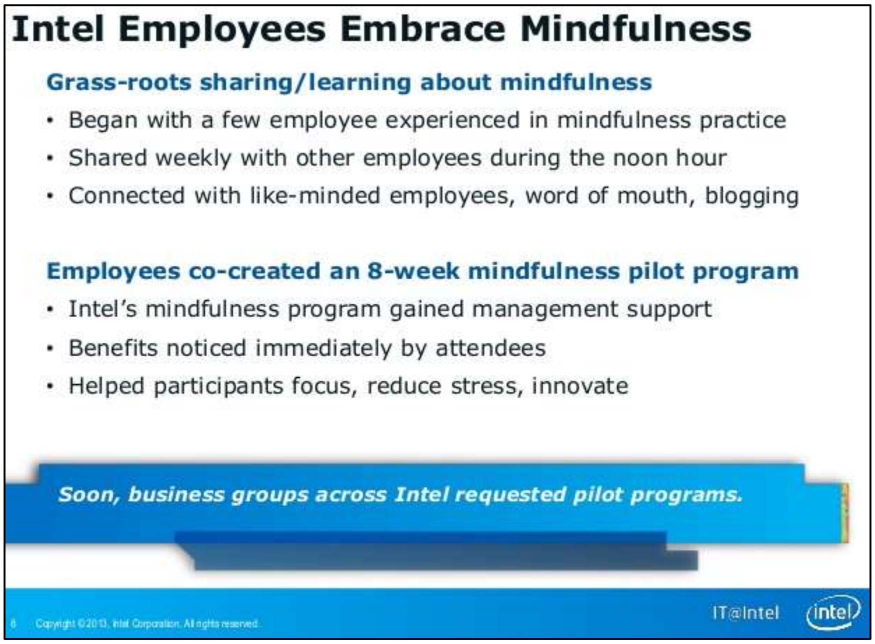


Fig. 1.47: Nurturing Innovation at Intel through Mindfulness [682]

1.26. Democracy and Innovation

As a democracy, decision-making has to take into account the concerns of diverse interest groups. Politicians who have to face the electorate once in five years (or sooner if the government falls prematurely) have few stakes in long-term plans that take more than five years to show results. **Yet, lasting changes in the innovation system have longer gestation periods**. For the people of the country, employment and having enough money to buy their next meal are more important than whether India is a technological superpower or not. If liberalization has to be sustained and built on, the fruits of liberalization have to go beyond the middle class in urban India. These concerns are important as we explore how India can build on the base it has created and build its industrial and services base. [396]

1.27. Innovation by Accident

1.27.1. The Microwave - Percy L. Spencer

Percy Spencer, an engineer at Raytheon after his WWI stint in the Navy, was known as an electronics genius. In 1945, Spencer was fiddling with a microwave-emitting magnetron — used in the guts of radar arrays — when he felt a strange sensation in his pants. A sizzling, even. Spencer paused and found that a chocolate bar in his pocket had started to melt. Figuring that the microwave radiation of the magnetron was to blame (or to credit, as it would turn out), Spencer immediately set out to realize the culinary potential at work. The end result was the microwave oven — savior of eager snackers and single dudes worldwide. [620]

1.27.2. Pacemaker - Wilson Greatbatch

An assistant professor at the University of Buffalo thought he had ruined his project. Instead of picking a 10,000-ohm resistor out of a box to use on a heart-recording prototype, Wilson Greatbatch took the 1-megaohm variety. The resulting circuit produced a signal that sounded for 1.8 milliseconds, and then paused for a second — a dead ringer for the human heart. Greatbatch realized the precise current could regulate a pulse, overriding the imperfect heartbeat of the ill. Before this point, pacemakers were television-sized, cumbersome things that were temporarily attached to patients from the outside. But now the effect could be achieved with a small circuit, perfect to tuck into someone's chest. [620]

1.27.3. Stainless Steel - Harry Brearly

Although extremely tough and durable, anything that is made of steel will eventually, with the passage of time, rust and crumble. For years, scientists and metallurgists attempted, in vain, to introduce new elements to steal in order to prevent rusting. The final solution, however, came from the failure of one such metallurgist named Harry Brearly. In 1912, Brearly set out to come up with a new and improved gun. Because guns are grooved in a spiral pattern, bullets spin, increasing accuracy. Unfortunately, friction between the bullet and the barrel leads to eventual wear. This is why Brearly was hoping to develop a steel alloy that would not erode. After continuously failing at his mission, Brearly's heap of discarded steel scraps grow larger and larger. Several months passed, when he noticed that one such "failure" might have some use, after all. This scrap of steel had retained all of its original luster, whereas others had begun to oxidize. The steel sample contained approximately 12% chromium, which reacted with the air's oxygen and created a thin, protective film. Brearly then noticed that, in addition to resisting rust, the film could restore itself from scratches, and resist stains. Thus, he dubbed his innovation "stainless steel". [621]

1.28. Innovation: Growth Engine for Industry & Nation

Modern economies are built with ideas, as much as with capital and labor. It is estimated that **nearly half the US' GDP**, for example, is based on **intellectual property**. [164]

On April 11, 2012, the U.S. Commerce Department released a comprehensive report, entitled "Intellectual Property and the U.S. Economy: Industries in Focus," which found that intellectual property (IP)-intensive industries support at least **40 million jobs** and contribute more than **$5 trillion dollars** to, or **34.8 percent of, U.S. gross domestic product (GDP)…** "Every job in some way, produces, supplies, consumes, or relies on **innovation, creativity**, and commercial distinctiveness," said Under Secretary of Commerce for Intellectual Property and USPTO Director David Kappos. "America needs to continue investing in a high quality and appropriately balanced **intellectual property system** that will promote innovative, open, and competitive markets while helping to ensure that the U.S. private sector remains **America's innovation engine.**" [244]

The article published in University World News namely "**Six-fold return for economy on university innovation funding**" stated that "Every pound invested in higher education innovation funding add at least £6 (US$9.70) in knowledge exchange income to the economy, according to a new report sponsored by the Higher Education Funding Council for England, or HEFCE, and launched on 30 April 2012." [47]

Leading privately held **businesses are putting greater emphasis on innovation as an engine for growth**, according to chief executives surveyed for **PwC** US's Private Company Trendsetter Barometer. Three-fourths (75%) of those businesses have made innovation a priority -- 33% of them to a great extent and 42% to some extent. Nearly half (47%) of innovation-focused private companies expect that their innovations (ranging from incremental to breakthrough) will have a significant impact on the way they do business over the next one to three years. [310]

Europe's future is connected to its power to innovate. The **Innovation Union**, an action-packed initiative for an **innovation-friendly Europe**, is the solution. It forms part of the Europe 2020 strategy that aims to create smart, sustainable and inclusive growth. [335]

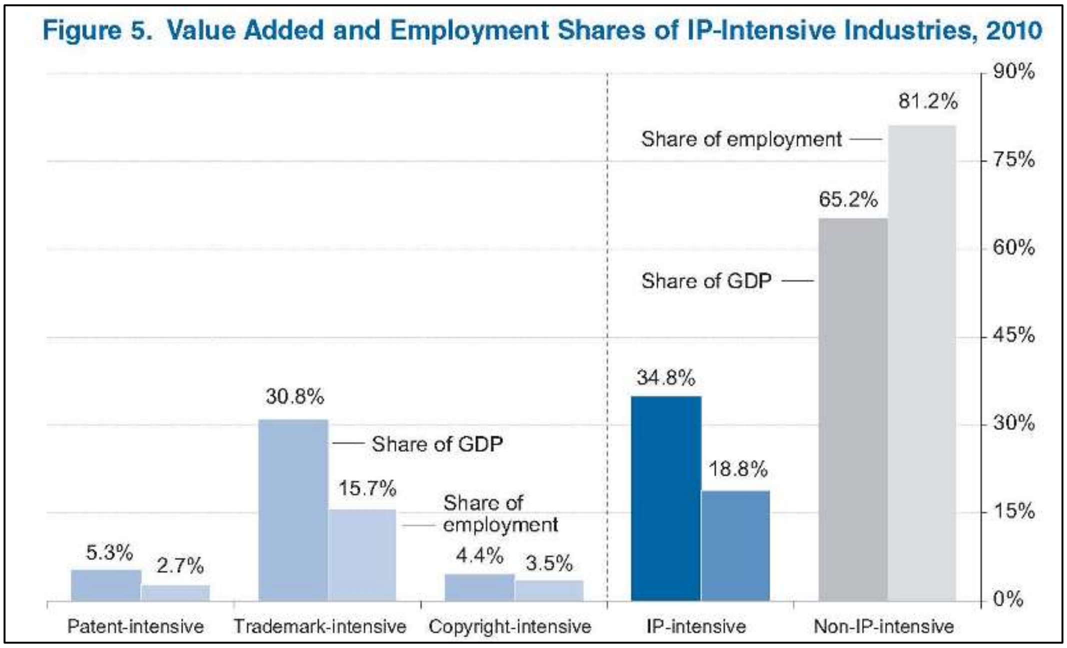


Fig. 1.48: IP Intensive US Industries [244]

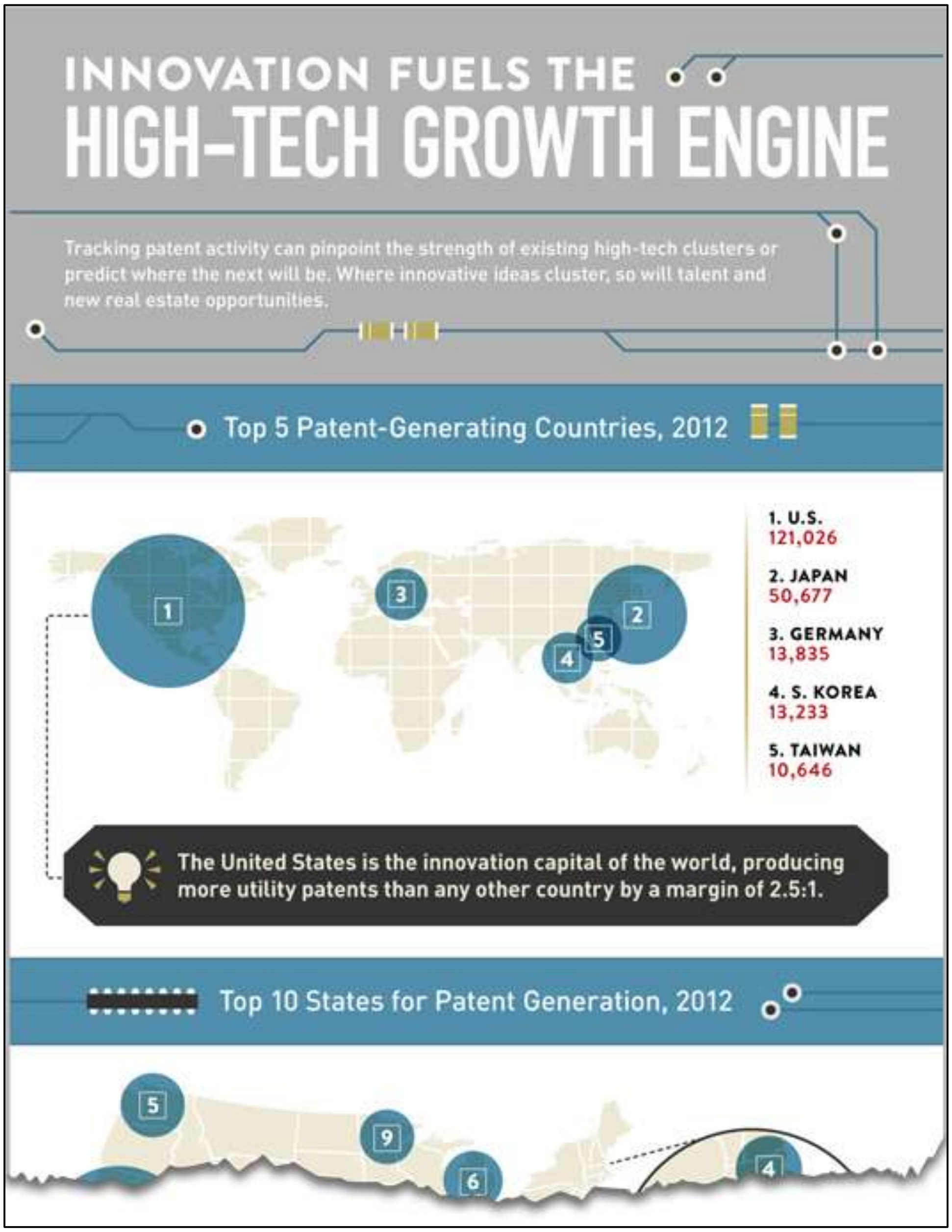
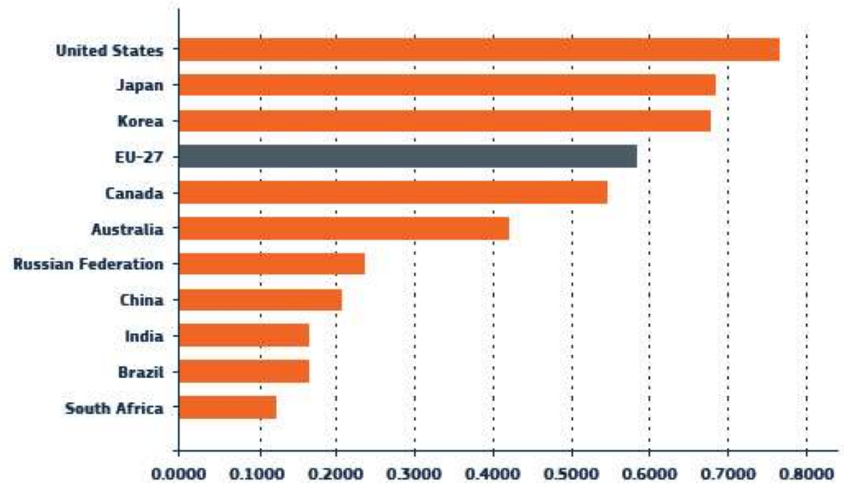


Fig. 1.49: Infographic Innovation Fuels the High-Tech Growth Engine [311]

The main economic driver of economic growth in the EU is innovation. This is why the EU needs to improve its performance in innovation, as shown in the graph below:

EU-27 PERFORMANCE IN INNOVATION COMPARED TO MAIN COMPETITORS - Innovation Union Scoreboard 2011



It is widely accepted that investments in research and innovation are driving long-term growth. The rate of return for publicly funded R&D is considered high.

But did you know that the countries that invest in R&D are recovering faster from the crisis – as the graph below shows?

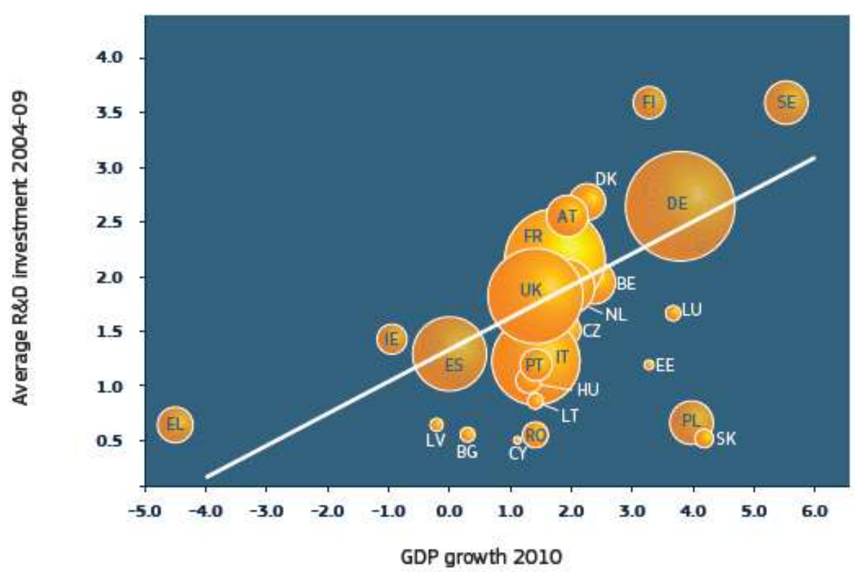


Fig. 1.50: Europe 2020 – Innovation Union: Innovation is main economic driver of growth [335]

Fig. 1.51: Europe 2020 – Innovation Union strategy has Highest Priority [335]

Fig. 1.52: Innovation: Key to Growth, Prosperity [218]

Innovation is the process that translates knowledge into **economic growth** and social wellbeing. It encompasses a series of scientific, technological, organizational, financial and commercial activities. From an economic development perspective, the concept of innovation has evolved from its purest connotations in terms of "invention" and "novelty" to refer more specifically to the exploitation of new knowledge predominantly for commercial gain. Innovation can be related to products, services, processes, management instruments or organizational structures. [37]

Innovation is considered by academics, governments and business leaders as necessary to transform organizations and **compete in a knowledge economy**. In this increasingly competitive global economy, businesses and enterprises that have the awareness to continually create, evaluate and successfully exploit their new ideas are more likely to survive and indeed flourish. [37]

Innovation is the driving force behind progress, which alone can make possibilities that did not exist before. Innovation is a creative act, in the purest sense of the word. When we innovate, we create value that was not there until we put our brain power to work. [179]

In today's world, the organizational progress heavily depends upon rate of innovation (see the following two diagrams).

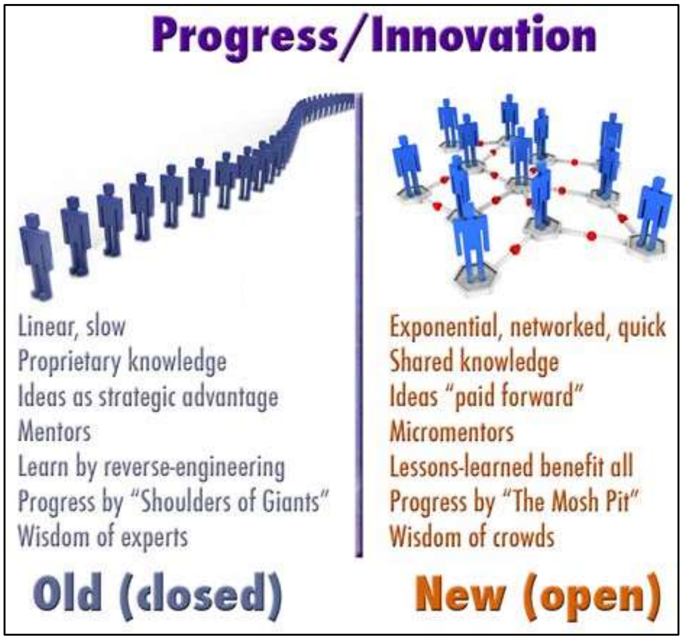


Fig. 1.53: Comparison of Progress (Old) and Innovation (New) [22]

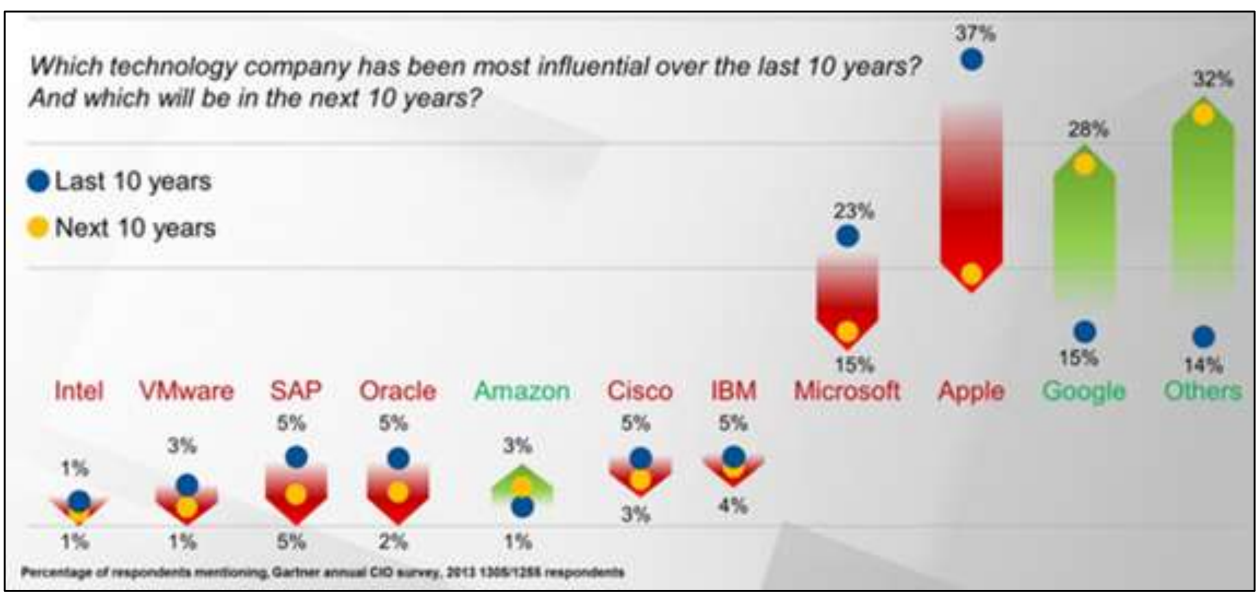


Fig. 1.54: Organizational progress heavily depends upon rate of innovation [19]

Chapter 2: Innovation Ecosystem, Culture, Clusters and Networks

*In the **conventional view**, innovation is something that just takes place idiosyncratically in "Silicon Valley garages" and research and development (R&D) laboratories. **But in fact**, innovation in any nation is best understood as being **embedded in a national innovation system** (NIS). Just as **innovation is more than science and technology**, an innovation system is more than those elements directly related to the promotion of science and technology. Rather, **it also includes** all economic, political, and other social institutions affecting innovation (e.g., a nation's financial system; organization of private firms; the pre-university educational system; labor markets; culture, regulatory policies and institutions, etc.). [629]*

*"**Build Innovation Ecosystems, not a Silicon Valley**" - David Parekh, Vice President, United Technologies Research Center USA [643]*

*Using an innovative process that includes training, patent circumvention, a focus on the process, and pigheaded determination to the innovative culture, has allowed **Samsung** to be a global leader in multiple industries. [665]*

2.1. Innovation Block Diagram

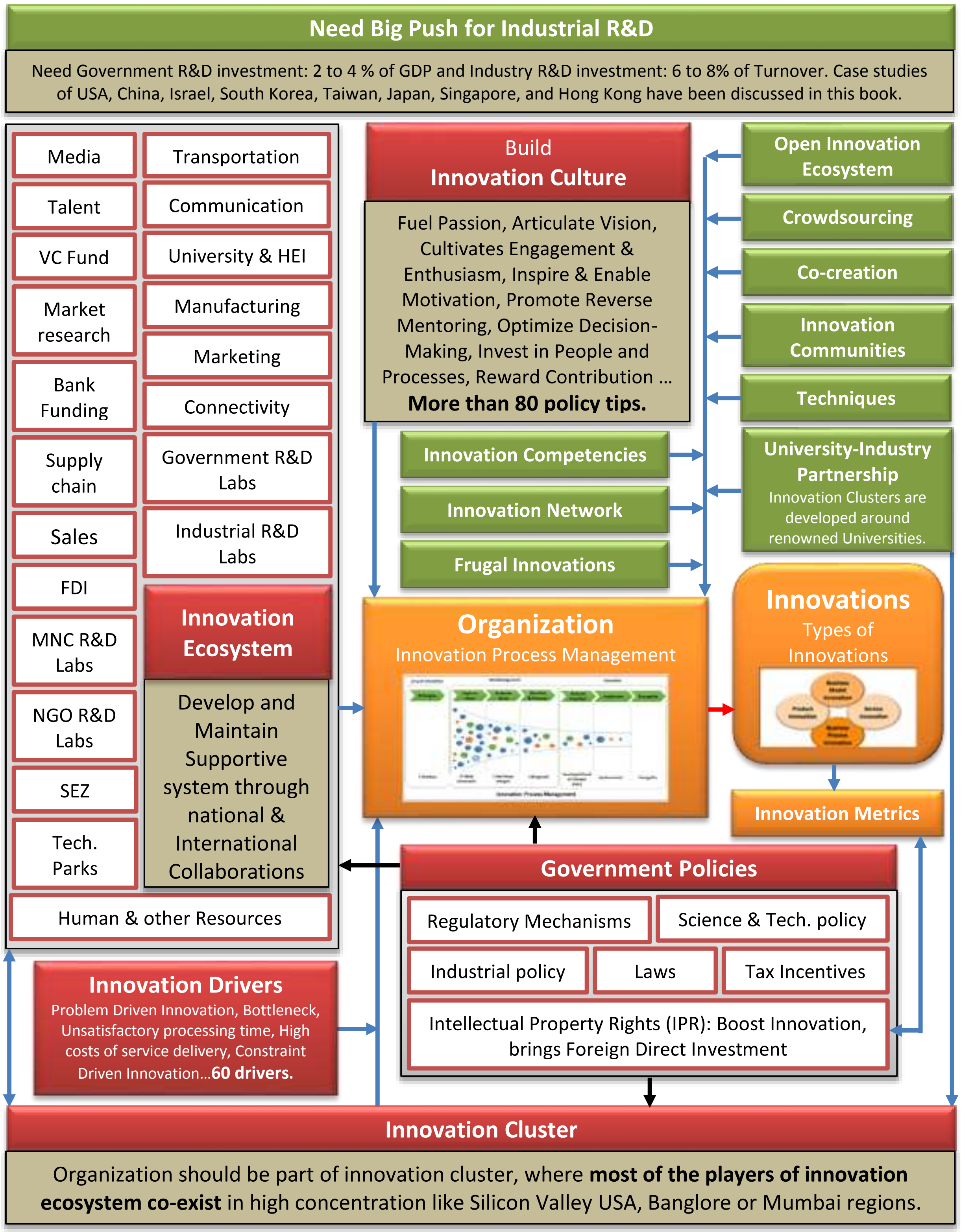


Fig. 2.1: Innovation Block Diagram

In Figure 2.1, the thumbnail image of organization and innovation types have been shown. The full images are shown in Figure 2.2 and 2.3 respectively. I would like to explain the concept of innovation with the help of these diagrams in the rest of this chapter.

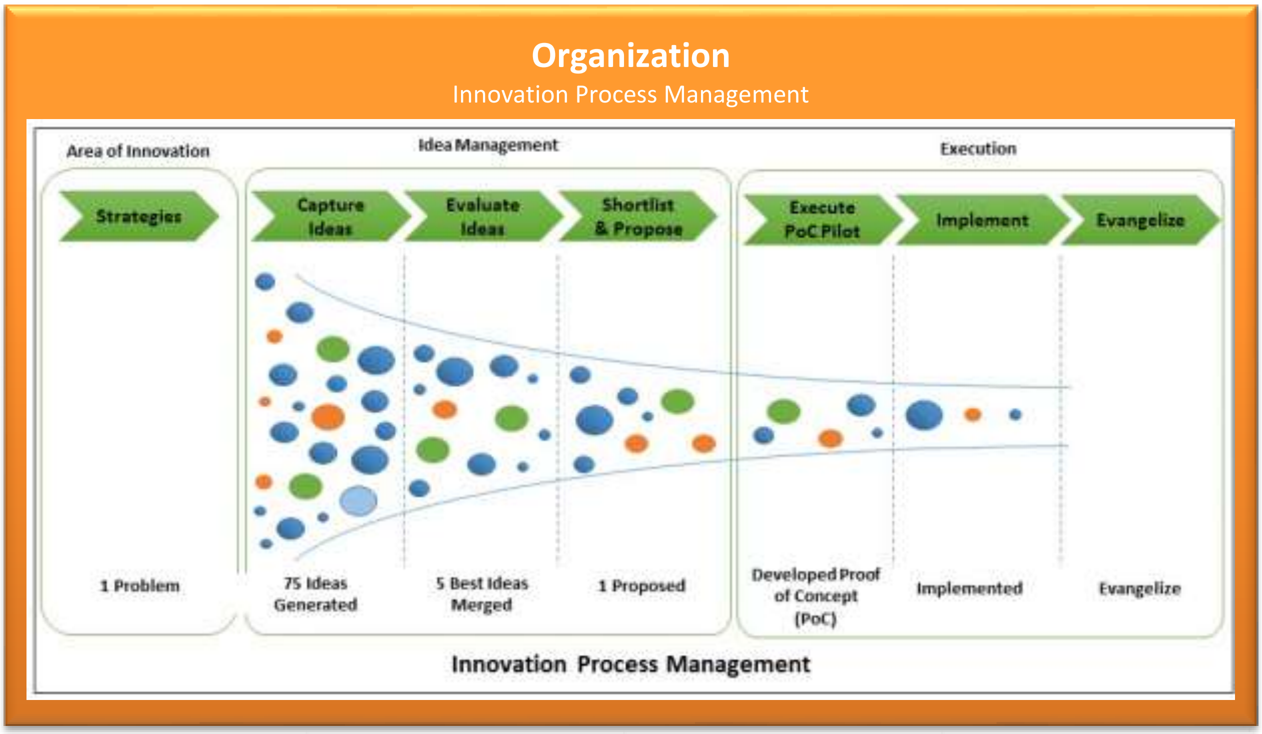


Fig. 2.2: Organization Use Innovation Process Management for nurturing Innovation

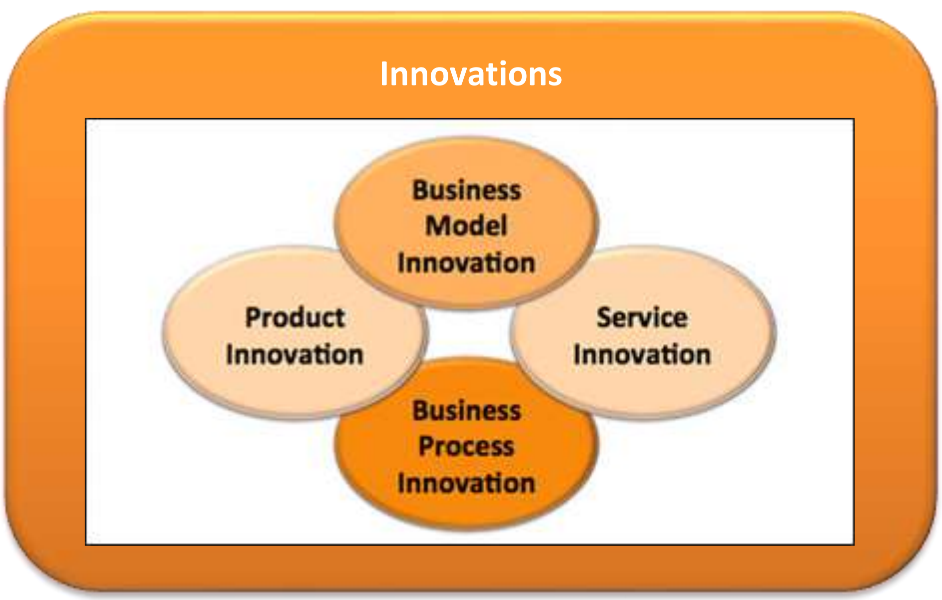
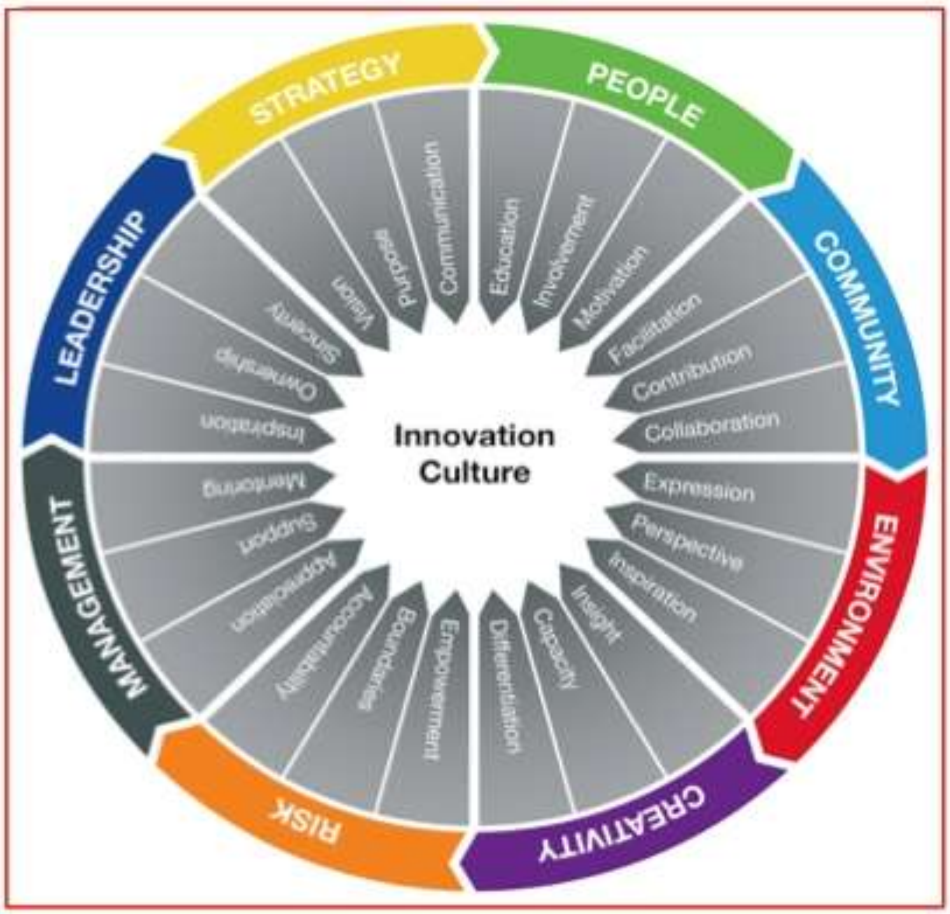


Fig. 2.3: Types of Innovations

2.2. Innovation Culture

The **innovation culture of an organization** constitutes the **institutional framework** for all actors involved in innovation processes. It includes all norms, values, ideals and mindsets which influence the behavior of the relevant stakeholders. As a cross sectional culture it is built and supported by all players. **There is no guarantee that an innovation culture will lead to innovation, but it certainly is a prerequisite**. [37]



Culture is an ecosystem of interconnected elements, primary ones in the outer ring and secondary ones inside. Changing any one element will affect one or more of the others. Diagram courtesy Cris Breswick

Fig. 2.4: Innovation Culture [13]

I have devoted one full chapter to discuss "how to build the culture of Innovation?" in this book.

2.3. Innovation Ecosystem

2.3.1. Elements of Innovation Ecosystem: Views Expressed by Experts

In this section, I have given number of views and diagrams for explaining Innovation Ecosystem because this concept is context dependent. That is, the elements of innovation ecosystem depend upon type of organization. There is a lot of variation. Thus there is little bit of redundancy but it is necessary.

Innovation ecosystem is a **network of multiple stakeholders** and **flow of interactions** between them. Ecosystem is characterized by dynamic linkages among multiple sub-systems. [133] [219]

Innovation ecosystems are the dynamic mixtures of individuals and organizations along with social, political, informational, technological, and financial contexts that spark creative responses to pressing social challenges. They are among the **loosest of all social collaborations** and often the aggregate outcomes are unintended, un-designed, and not consciously pursued by the actors in them. [205]

Fig. 2.5: Innovation Ecosystem [133] [150]

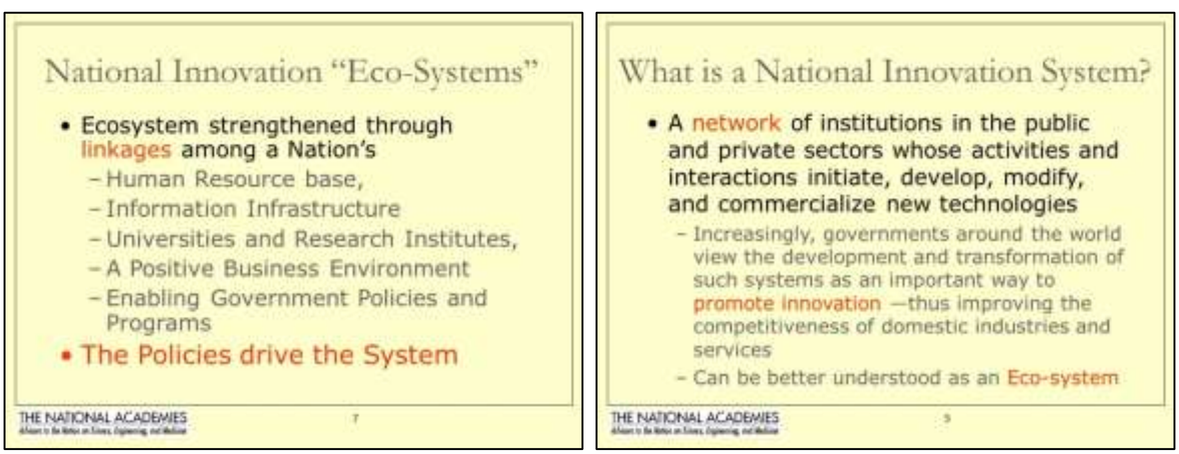
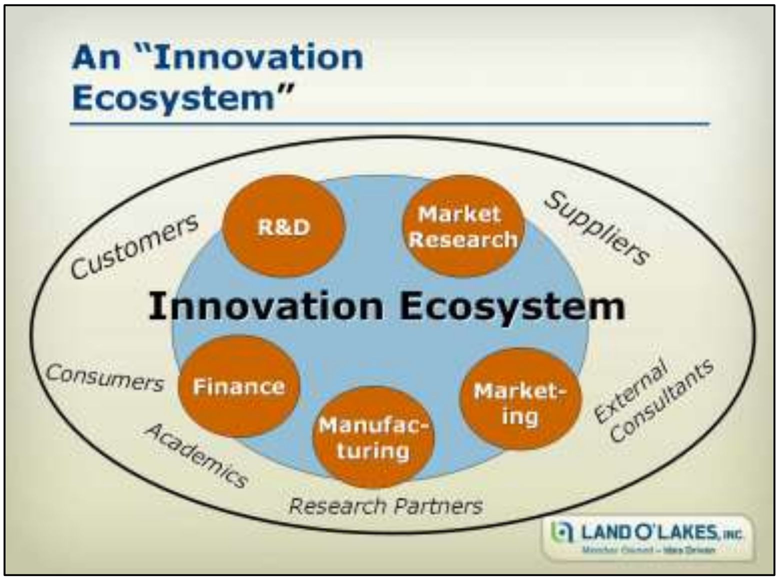


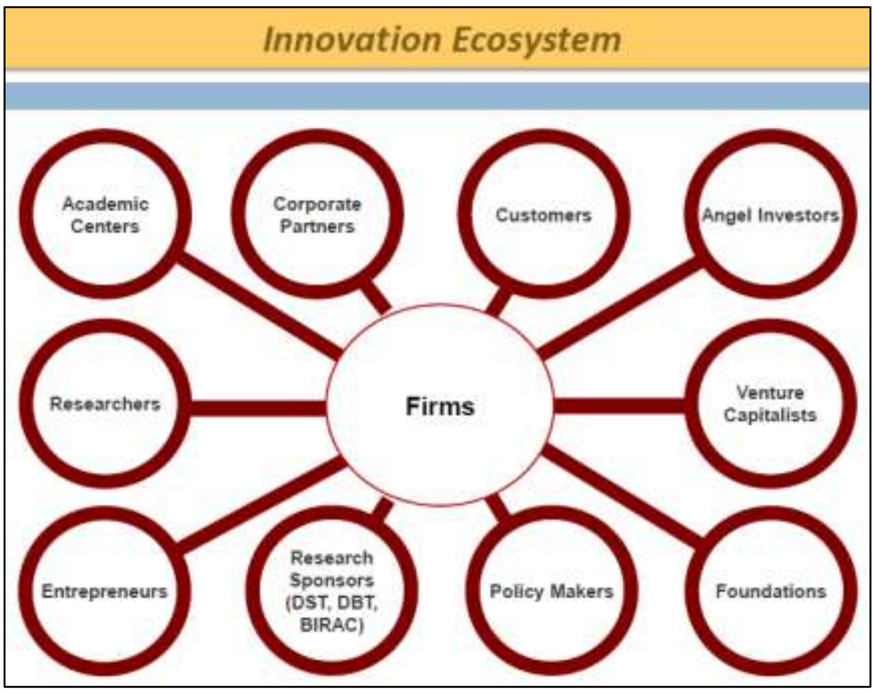
Fig. 2.6: Ecosystem: Linkage among subsystem [219]

"Ecosystem" is a term combining the words "**eco**" and "**system**". The former has its origin in ecology and refers to the relation of living things to their environment. The latter originates from Greek and stands for an organized whole or body. Ecosystem as a scientific concept derives from the study of natural ecological systems. In a biological sense, an "ecosystem is a set of organisms interacting with one another and with their environment of non-living matter and energy within a defined area or volume". [184]

Innovation ecosystem is the term used to describe the **large and diverse array of participants and resources** that contribute to and are necessary for ongoing innovation in a modern economy. This included entrepreneurs, investors, researchers, university faculty, venture capitalists as well as business development and other technical service providers such as accountants, designers, contract manufacturers and providers of skills training and professional development. [181]

Fig. 2.7: Innovation Ecosystem [133] [150] [252]


An "Innovation Ecosystem"
Customers
R&D
Market Research
Suppliers
Innovation Ecosystem
Consumers
Finance
Manufac-turing
Market-ing
External Consultants
Academics
Research Partners
LAND O'LAKES, INC.


Innovation Ecosystem
Academic Centers
Corporate Partners
Customers
Angel Investors
Researchers
Firms
Venture Capitalists
Entrepreneurs
Research Sponsors (DST, DBT, BIRAC)
Policy Makers
Foundations

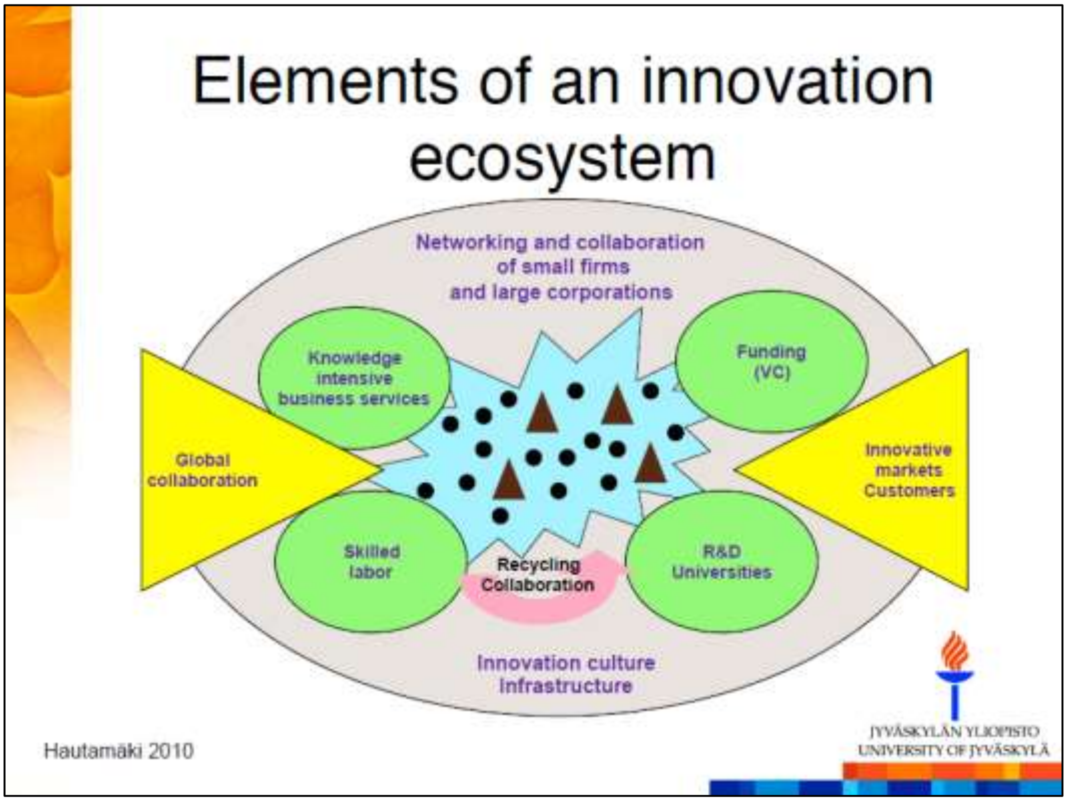


Fig. 2.8: Innovation Ecosystem [133] [150] [185] [223] [252]

Mercan & Göktaş (2011) specify that an "innovation ecosystem consists of **economic agents** and **economic relations** as well as the **non-economic parts** such as **technology, institutions, sociological interactions and the culture**", suggesting that an innovation ecosystem is a hybrid of different networks or systems. [184]

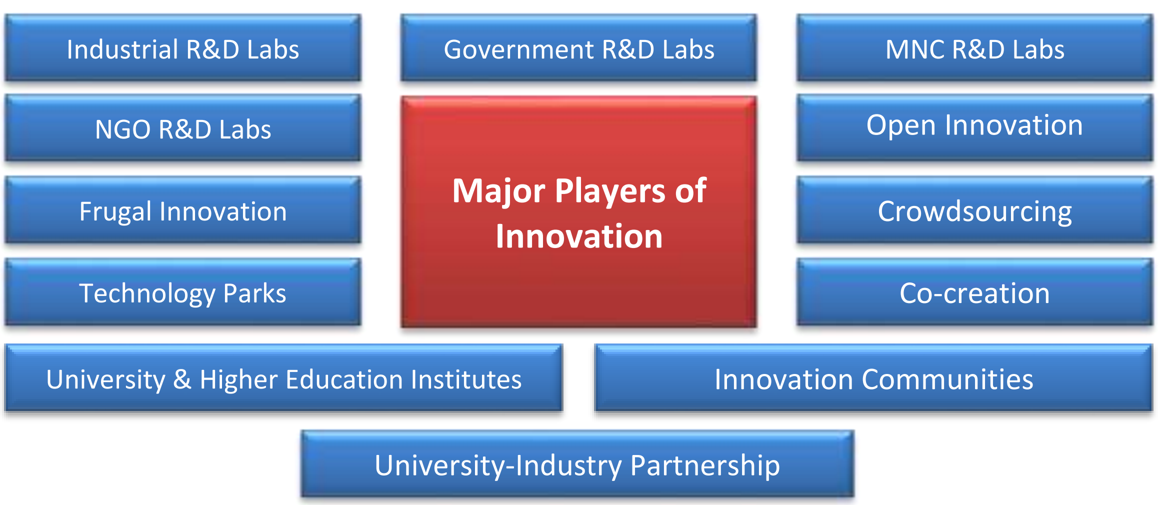


Fig. 2.9: Major Players of Innovations

2.3.2. Advantage of Innovation Ecosystem

Anil Kakodkar Chairman, Research Advisory Council, JNNSM at Department of Atomic Energy stated that "Innovation Eco-system requires a conducive environment for collaboration among diverse set of people- researchers, developers, entrepreneurs, end beneficiary etc. **such that a worthwhile idea regardless from where it emerges can be carried forward all the way up to the intended destination**." [240]

According to Adner (2006), the fact that innovations **rarely succeed in isolation** but are dependent on many types of complementary innovations. Therefore, an ecosystem **allows firms to create value that no single firm could make alone.** [184]

Ron Adner, Professor, Business Administration, Tuck School of Business at Dartmouth and author of "The Wide Lens: A New Strategy for Innovation" stated that "**Today's world no longer allows you to be a successful lone innovator; success requires an entire ecosystem. It is no longer enough to manage your innovation. Now you must manage your innovation ecosystem**." [191] [192] [193]

Land O'Lakes President and CEO Chris Policinski stressed the importance of innovation to business success as a featured speaker at the recent Midwest Food and Agribusiness Executive Seminar held at Purdue University. Policinski stressed that a **culture of innovation, supported by an "Innovation Ecosystem" is key to translating insights, discipline, processes and capabilities into successful innovation.** He indicated that such an ecosystem involves diverse functions including (but not limited to)

- Market research
- Product research and development
- Finance
- Manufacturing
- Supply chain
- Marketing and
- Sales

"An effective innovation ecosystem cuts across the organization and involves a wide range of internal and external constituents… building, nurturing and sustaining a culture of innovation" is essential to success in today's complex and highly competitive economic and business environment" Policinski said. [185]

An innovation ecosystem comprises all stakeholders required to enable an innovation and entrepreneur based economy in the area of influence. The components of the innovation ecosystem include: the innovation actors, the interactions that take place between actors in the ecosystem to facilitate innovation, and the agencies associated to policy instruments used **for promoting innovation**. [187]

An **innovation system** is an **intellectual construct**, a concept that is useful in drawing out the need for **complex interactions between multiple players** in order to create constructive and useful change. The innovation system is also a **social construct**, both in the sense that the concept has arisen from the intellectual activity of people but also, and perhaps more importantly, in the sense that the system results from productive **interactions** between people working within the different components of the system. In effect this means that the system has **no concrete existence** – there is **no set pathway through a defined group of institutions to achieve effective innovation**. Instead, there are many individual systems and each innovation depends on its own unique set of interactions between a **diversity of players**. This is why framework conditions that facilitate rather than impede **interactions and cooperation are so important**. This is also why the ingredients for significant innovation in different sectors can be so diverse. [294]

Tathagat Varma, Sr. Director-Business Operations, Yahoo! Software Development India Pvt. Ltd, Bangalore, while answering the question "Why do we **need** an **ecosystem to foster a culture of innovation** in the IT industry?" said that "Back in the **old days, most R&D was capex-driven**. You needed large investments to have the latest and the greatest gizmos and co-located teams to conduct research and drive them into innovative products. **Innovation was something typically led by large companies**. However, **globalization and the Internet have made it possible for talent to be located anywhere and yet collaborate in real-time**. For instance, P&G made a compelling case in a 2006 HBR article that, for every P&G researcher, there were 200 scientists elsewhere in the world who were just as good, so instead of a pure R&D, they decided to get in 'C&D' (Connect & Develop) innovation model and set a target of 50 per cent products from ideas originated externally! And the model works for them. In the IT industry, we are confronted with similar challenges. **No company can have all the top minds on its payroll**. And, with the technology obsolescence rate being so high, most players can't specialize in every single technology. Further, some of the most complex problems require **cross-industry collaboration at various levels**. Having a **robust ecosystem of freelancers, app developers, researchers, early adopters, and VCs is but a necessity for the IT industry today**." [183]

2.3.3. Example of Innovation Ecosystem

According to Boston Consulting Group (BCG) Survey the second top most innovative company is Google, a business that has expanded far beyond web searches. With its wide suite of existing products embedded in most people's daily lives, **Google has almost become a byword for the internet itself**. But more importantly, in the innovation stakes, Google has **invested big money** in other technological realms with ventures in **artificial intelligence**, **robotics**, **self-driving cars** and now **cancer-searching pills**. The unbelievable list of huge innovative Google products can be found at Wikipedia [656] [657]

Over 1 billion users per week. Over 100 billion searches per month. Over 1 billion Android activations. Over 1 billion YouTube users per month. That's the stats of Google. [658]

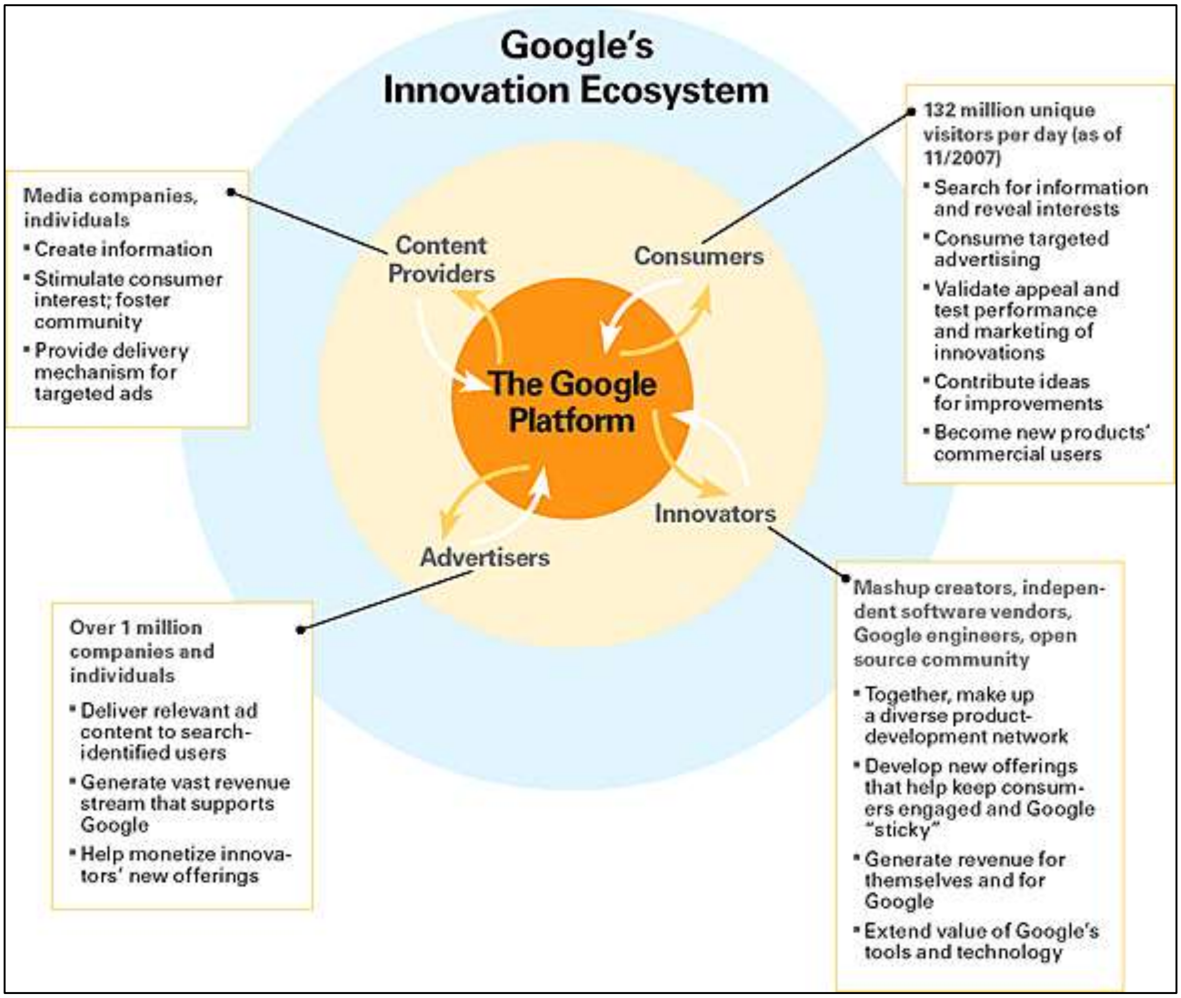


Fig. 2.10: Google Innovation Ecosystem [659]

The national ecosystem is always a complex phenomenon. Let's see diagram of Australian National Innovation Ecosystem.

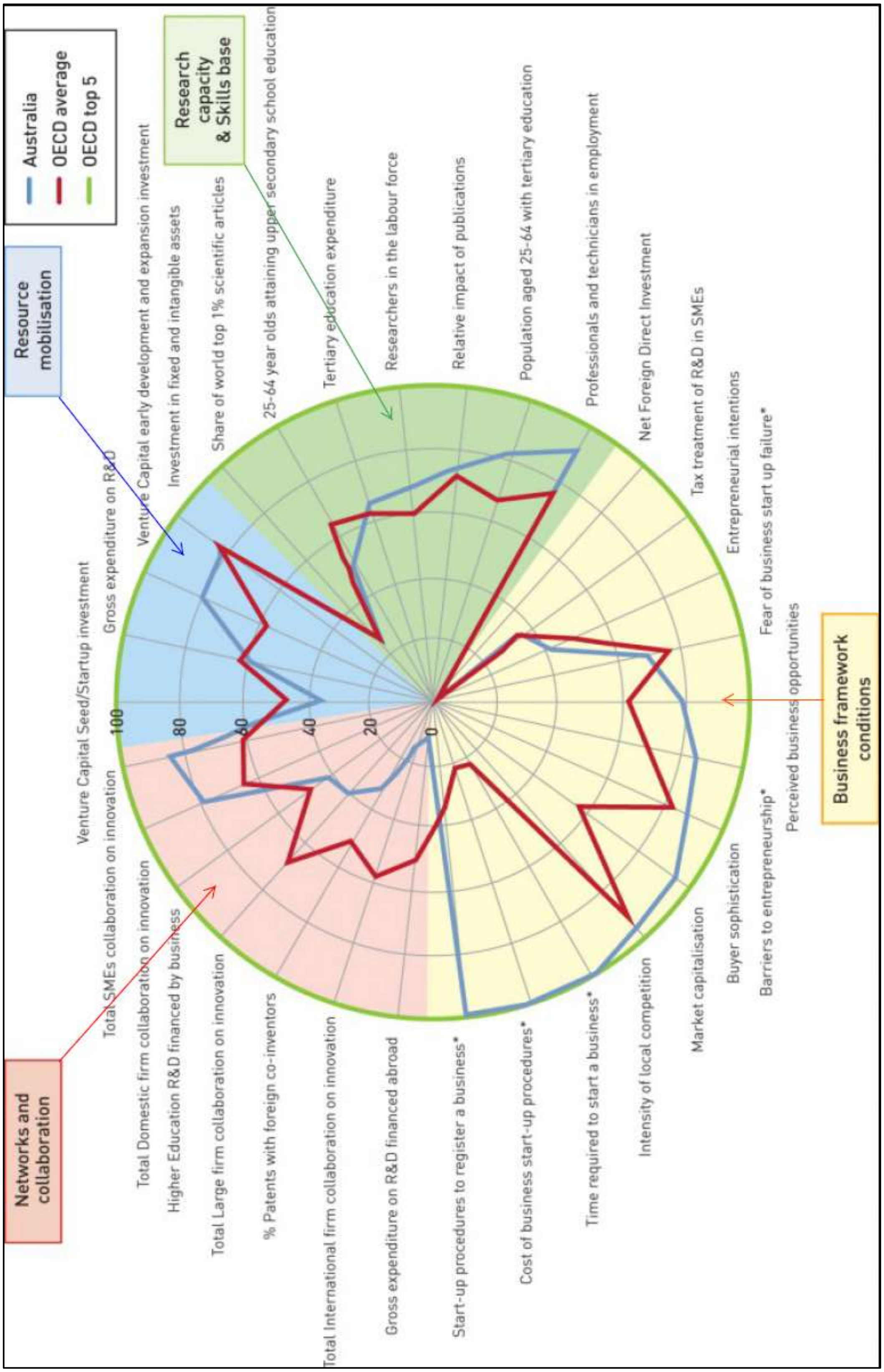


Fig. 2.11: Australia National innovation system input indicators [332]

2.3.4. One Organization Can Be Associated with Several Ecosystems

Several industrial-driven innovation ecosystems could usually coexist and interact in the same geographical area or in a closely integrated industrial sector; then, **one given entity could be associated to several industrial ecosystems** under the principle of non-exclusivity; this is typically the case of university or public research organizations (PRO) partners. These are not necessarily isolated ecosystems and industries can also cooperate thematically. The potentiality of innovation clusters or regions to attract investment and quality jobs depends on the coexistence of several ecosystems with potential inter-cross interactions. [187]

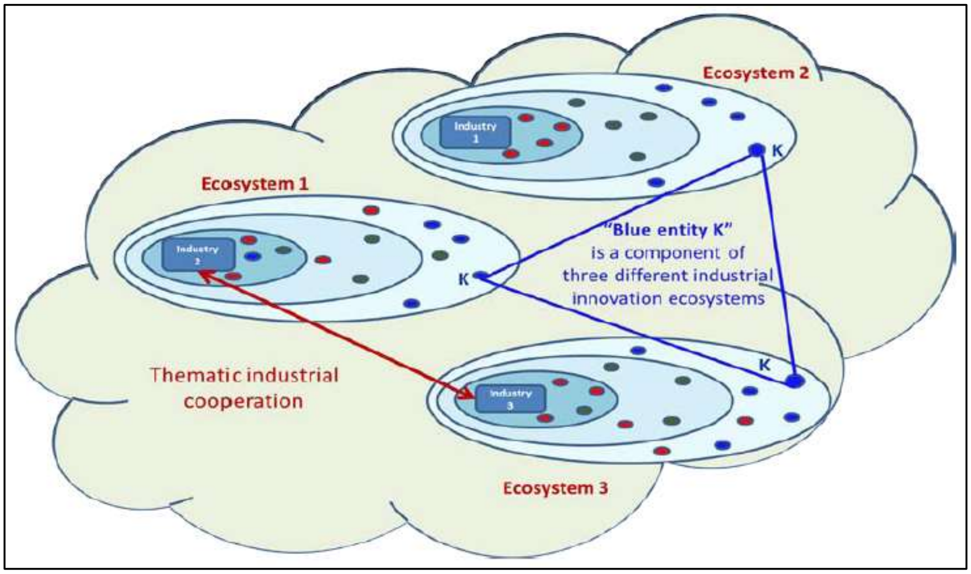


Fig. 2.12: One given entity could be associated to several industrial ecosystems [187]

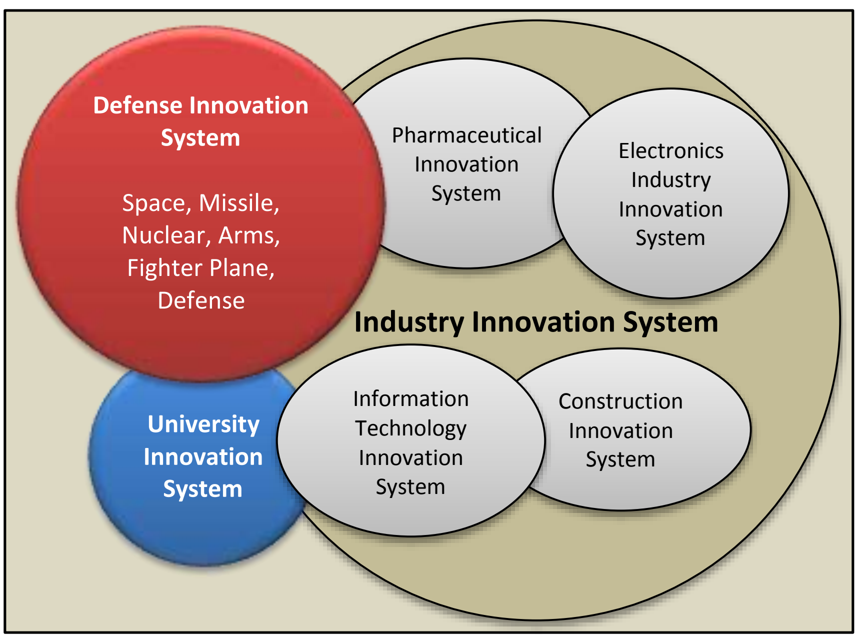


Fig. 2.13. Innovation System of Nation: Set of Interconnected innovation systems

The networks of institutions, disciplines and policies that interact to form the **defense innovation system** may overlap with but will be different from those that contribute to the **construction sector innovation system** or the **education system innovation system**. Each of these has some unique and some shared characteristics and institutions. Innovation in defense requires a broad integration of many different disciplines and a readiness to change priorities and approaches in response to the improved understanding that results, but this is not unique. Addressing issues such as feeding a growing world population with shifting tastes, ensuring energy security or improving health outcomes **all require a trans-disciplinary approach** that draws upon institutions and people from all areas of society, domestic and international. **A system which does not embrace all these components will be defective and lead to perverse outcomes**. [294]

2.3.4. Examples: Product Failed Because of Lack of Appropriate Ecosystem

The **innovation game is changing**. Delivering great products is no longer sufficient for success. Rather, what matters is delivering great solutions. This shift from products to solutions matters to everyone. In industries ranging from consumer electronics to construction and from media to mining, the firms seizing the lead are those that can best **align ecosystems of offers and partners**. In the past, product-focused success depended on exploiting capabilities – in branding, manufacturing, distribution, etc. – to deliver the best product. In contrast, today's champions focus on carrying over relationships – with both consumers and partners – to deliver the best experience. [193]

> In the 1990s Michelin developed a revolutionary new kind of tire with sensors and an internal hard wheel that could run almost perfectly for 125 miles after a puncture. A light on the dashboard would notify the driver of the puncture, and the driver could then attend to the problem at his leisure. This would make customers' lives much easier and much safer, and make lots of money for the company. The company built a powerful alliance with Goodyear to reach almost 40% of the world's tire market with the product. It signed up Mercedes to put the tire on new cars, and other manufacturers followed, including Audi and Honda. Yet by 2007 the product was such a failure that Michelin had to abandon it. Why? **The company hadn't confronted the entire ecosystem the tire would rely on**. It had overlooked the garages that repair punctured tires and hadn't gotten them on board. Those garages needed expensive new equipment they had neither money nor space for, and they had to have that equipment long before it would get heavy use. They saw no reason to acquire it. And Michelin didn't see that one coming. [191] [192]

Sony failed to grapple with the whole ecosystem when it brought out its Reader for e-books in 2006. It didn't deal with the economic and legal challenges e-books would pose for authors and publishers; it didn't offer a compelling enough **digital rights management** solution; and it didn't know how to build a **good online store**. **Publishers didn't sign on, and neither did readers**. The next year Amazon came along with Kindle and got it all right. "The key difference was the way in which **Amazon aligned the ecosystem** to bring its value proposition to life. . . . Amazon did not simply bully publishers into supporting the Kindle. Amazon created conditions in the ecosystem that made joining the long-awaited e-book revolution a more attractive proposition for publishers than any previous attempt. Among other things, the **company devised a very strong digital rights management system** (you might not like that you can't copy or pass along books, but publishers love it), and at first it sold books for less than it paid publishers, sacrificing profits to build up its e-book store and sell $399 Kindle devices. "It took on far more responsibility for organizing the system than did Sony. While Sony assumed its red lights would somehow work themselves out, Amazon turned red to green by taking the lead and blazing a trail for the entire industry." [191]

High-definition televisions should, by now, be a huge success. Philips, Sony, and Thompson invested billions of dollars to develop TV sets with astonishingly high picture quality. From a technology perspective, they succeeded. Console manufacturers have been ready for the mass market since the early 1990s. Yet the category has been an unmitigated failure, **not because the consoles are deficient, but because critical complements such as studio production equipment, signal compression technologies, and broadcasting standards were not developed or adopted in time**. Underperforming complements have left the console producers in the position of offering a **Ferrari in a world without gasoline or highways**—an admirable engineering feat, but not one that creates value for customers. Today, more than a decade later, the supporting infrastructure is finally close to being in place. But while the pioneering console makers waited for complements to catch up, the environment changed as new formats and new rivals emerged. An innovation that was once characterized as the biggest market opportunity since color TV is now competing for consumer attention in a crowded market space. The HDTV story is a poster child for the **promise and peril of innovation ecosystems—the collaborative arrangements through which firms combine their individual offerings into a coherent, customer-facing solution**. Enabled by information technologies that have drastically reduced the costs of coordination, **innovation ecosystems have become a core element in the growth strategies of firms in a wide range of industries**. While leading exemplars tend to come from high-tech settings (think Intel, Nokia, SAP, and Cisco), ecosystem strategies are being deployed in industries as varied as commercial printing, financial services, basic materials, and logistics provision. **When they work, ecosystems allow firms to create value that no single firm could have created alone**. The benefits of these systems—discussed under such labels as platform leadership, keystone strategies, open innovation, value networks, and hyperlinked organizations—are real and well publicized. [182]

2.4. Open Innovation Ecosystem, Innovation Crowdsourcing & Co-Creation

The Rise of Open Innovation At the same time that new players are rising, the process of innovation itself is undergoing revolutionary change. As Henry Chesbrough has pointed out, the **traditional internally focused model for innovation is becoming obsolete**. To remain competitive in today's information rich environment, companies need to leverage both "**internal and external sources of ideas and take them to market through multiple paths**." Indeed, companies such as **Apple** have prospered in an environment of **open innovation**, integrating new technologies, components, design expertise, and low-cost Asian manufacturing capabilities into breakthrough products. [225]

Factors facilitating the open innovation process can be grouped based on the following dimensions: resources, governance, strategy and leadership, organizational culture, human resources management, people, partners, technology and clustering. [184]

The article of Harvard Business Review stated that "To answer the most vexing innovation and research questions, crowds are becoming the partner of choice. **Apple has turned to large numbers of users and developers distributed around the world to propel its growth by creating apps and podcasts that enhance its products.** Biologists at the **University of Washington** used crowds of external contributors to map the structure of an **AIDS-related virus** that had stumped academic and industry experts for more than 15 years. Despite a growing list of success stories, only a few companies use crowds effectively—or much at all… Over the past decade we've studied dozens of company interactions with crowds on innovation projects, in areas as diverse as genomics, engineering, operations research, predictive analytics, enterprise software development, video games, mobile apps, and marketing." [255]

Companies ranging from digital media firms to consumer-packaged-goods concerns are using crowdsourcing to rapidly drive innovation, improve products and increase customer satisfaction. Using the crowdsourcing model, companies might break big-data projects into micro tasks that are then farmed out to the "crowd." [256]

Various principles and concepts are used for managing research and innovation. You are probably familiar with these buzzwords: **crowdsourcing**, **open innovation** and a more recent one, **co-creation**. Organizations are gradually moving away from traditional work models; they are becoming a lot bolder and more inclusive in their approaches to innovation. As an innovation and idea management company we have witnessed successful use and implementation of these processes. Although these concepts are complementary they reflect different applications of innovation and idea management. So, what are the major differences between these three concepts? [257]

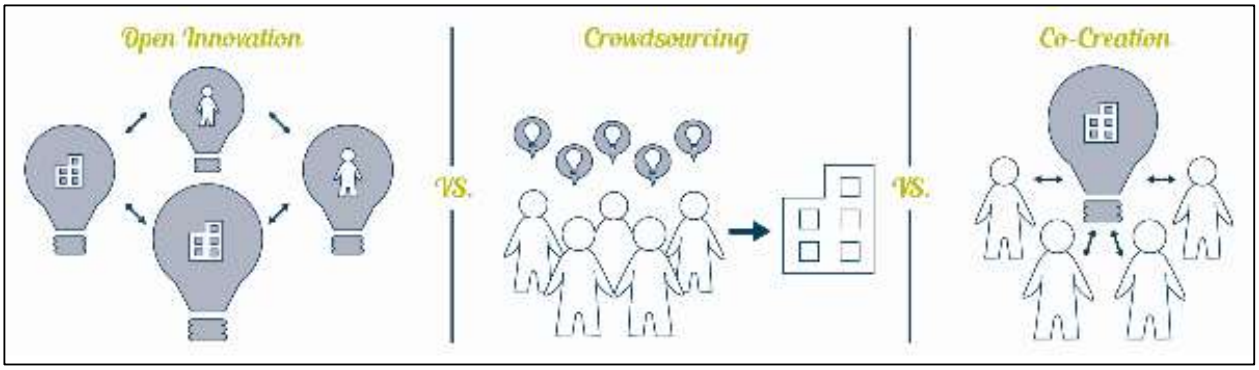


Fig. 2.14: Difference between Open Innovation, Crowdsourcing, Co-Creation [257]

2.4.1. Open Innovation Ecosystem

Open innovation means creating and innovating with external stakeholders: customers, suppliers, partners and your wider community. Companies are increasingly seeking to work and source knowledge beyond their boundaries. [257]

Henry Chesbrough defines open innovation as "the use of purposive inflows and outflows of knowledge to accelerate innovation. With knowledge now widely distributed, companies cannot rely entirely on their own research, but should acquire inventions or intellectual property from other companies when it advances the business model (…) Competitive advantage now often comes from leveraging the discoveries of others. An "open" approach to innovation leverages internal and external source of ideas." [257]

Open innovation creates an environment where individuals and organizations can actively get involved in the creation of mutually beneficial solutions. Through open innovation decision making is becoming a truly **democratic process**. It allows for a bolder, wider approach to problem solving. It suggests interacting with broader groups of stakeholders and it builds collaborative community engagement around specific challenges and issues: ideas and input flow into organizations from outside and smart, innovative solutions are easily generated. Open innovation is an inclusive, social way of solving complex issues and improving processes. [257]

2.4.2. Crowdsourcing

Crowdsourcing occurs when an organization **outsources projects to the public**. An organization decides to tap into the knowledge of a wider crowd and input is sourced from a **large and undefined group of people**. Crowdsourcing requires a **lower level of engagement** and involvement than open innovation and co-creation. An organization using crowdsourcing will set a challenge to the public and ask for opinions, insight and suggestions. It is an open call to the public whereby the organization solicits solutions from the crowd – not genuine contribution and collaboration. Open innovation and co-creation imply a stronger involvement from the stakeholders who are included in the value and creation process. [257]

Some organizations are beginning to experiment with an approach called crowdsourcing—the act of taking a task traditionally performed by one individual and outsourcing it to a large, undefined group of people.

The web-based company InnoCentive, for example, acts as a broker for crowdsourcing solutions to difficult research and development challenges. The organization has outsourced traditionally in-house R&D functions to create an "innovation marketplace" that connects companies and academic institutions seeking breakthroughs with a global network of more than 125,000 scientists, inventors, and entrepreneurs interested in developing creative solutions. A recent partnership with the Rockefeller Foundation is now allowing select nonprofits to use the InnoCentive process to post problems related to addressing the needs of poor and vulnerable populations and offering rewards to innovators who solve them. [36]

Other organizations, like the X-Prize Foundation, are using competition to help catalyze innovation and stimulating activity focused on particular goals. The foundation runs competitions that put forward multi-million dollar awards to the first team to achieve certain goals. Its first competition provided a $10 million prize to the first private team to design and launch a spacecraft that could carry people more than 100 kilometers above the earth's surface. The competitions, now being proposed in the areas of space, energy, automobiles, education, and other social issues, represent an alternative to direct research funding, and are seen as a way to create a "marketplace" for innovative solutions. [36]

2.4.3. Co-creation

While open innovation suggests active collaboration between different organizations and the sharing of intellectual property, **co-creation relates more specifically to the relationship between an organization and a defined group of its stakeholders, usually its customers**. The most common definition is: "An active, creative and social process, based on collaboration between producers and users that is initiated by the firm to generate value for customers.". Co-creation means **working with the end users** of your product or service to exchange knowledge and resources, in order to deliver a personalized experience using the company's value proposition. While crowdsourcing is people creating a great idea for you, co-creation is about people working with you to make a good idea even better. Co-creation is also a way of enhancing customer engagement by directly involving them in the company's value creation and product development processes. [257]

You can visit ww.15inno.com for number of examples for Open Innovation and Crowdsourcing. [488]

2.5. Two Models Based on Leadership of Ecosystem: Technology Park and University Industry Partnership

- **Technological Park Model**: The technological park model developed in the eighties, **where not a single company takes the leadership of the ecosystem**; in this case it corresponded to regional or national authorities to provide some attractiveness (via common infrastructures or economic incentives such as tax-reduction schemes) to favor the location of companies and other actors in a given geographical area to boost regional/local growth. [187]
- **University Industry Partnerships** or **University Driven Open Innovation Ecosystems**: The **same ideas** can be applied to university-driven ecosystems generated when one world-wide recognized research university acts as an attractor for developing and transferring disruptive ideas through spin-offs or other partnerships with consolidated high-tech companies. [187]

2.6. Government Policies Control the Innovation Ecosystem

A number of policy instruments are used by Government to encourage innovation. These include:

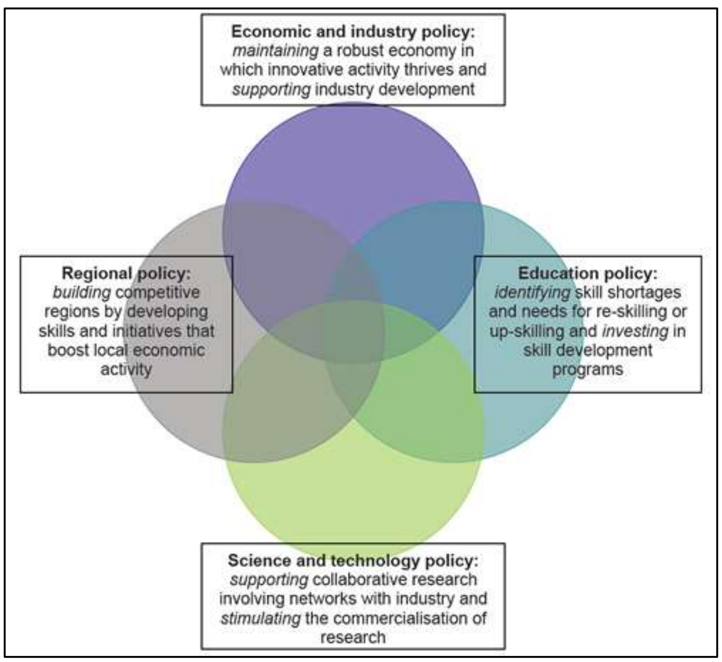


Fig. 2.15: Innovation & Government Policies [260]

Over the decades, India's **innovation strategies** have been guided by the **S&T policy statements**, while **industrial policy resolutions/statements have given direction to the development of manufacturing enterprises**. These twin processes have tried to ensure that India is able to develop a sufficiently robust manufacturing base and at the same time build a sound S&T infrastructure and create a high-skilled manpower base. [45] [46]

2.7. Innovation Cluster

Porter (1998) defines **clusters** as geographical concentration of specialized suppliers, service providers, organizations like universities, commercial unions and interconnected enterprises which they compete against each other and at the same time they collaborate in a specific industry and related industries. Member organizations engage in price competition and product differentiation, but they cooperate in acquiring supplies, gaining research and development. Universities help other agents of cluster enhancing new knowledge and technology, business associations try to create favorable business environment. Clustering also bring new advantages in case of attracting qualified labor. Clusters are **interrelated industry groups**. A cluster has **two components**. They are organizations in the clusters and their relations with each other. Interrelated organization groups are close to each other, thus **geographical proximity** is one of the key feature of a cluster. Connections among organizations can be **vertical** like seller buyer relations or **horizontal** like providers of similar services, users of similar supplies and users of similar technologies. These connections include useful social relations and social networks as well. Geographical proximity causes easier communication and value creation through networks. Level of cluster development depends on means the strength of interconnections among private enterprisers which are the living organisms of innovation ecosystem. Level of cluster development is measured by Global Innovation Index 2009-2010 for 132 countries. [254]

Clusters that accelerate regional innovation are not simply agglomerations of like-situated firms. Instead, regional innovation clusters form around an ethic of open innovation.

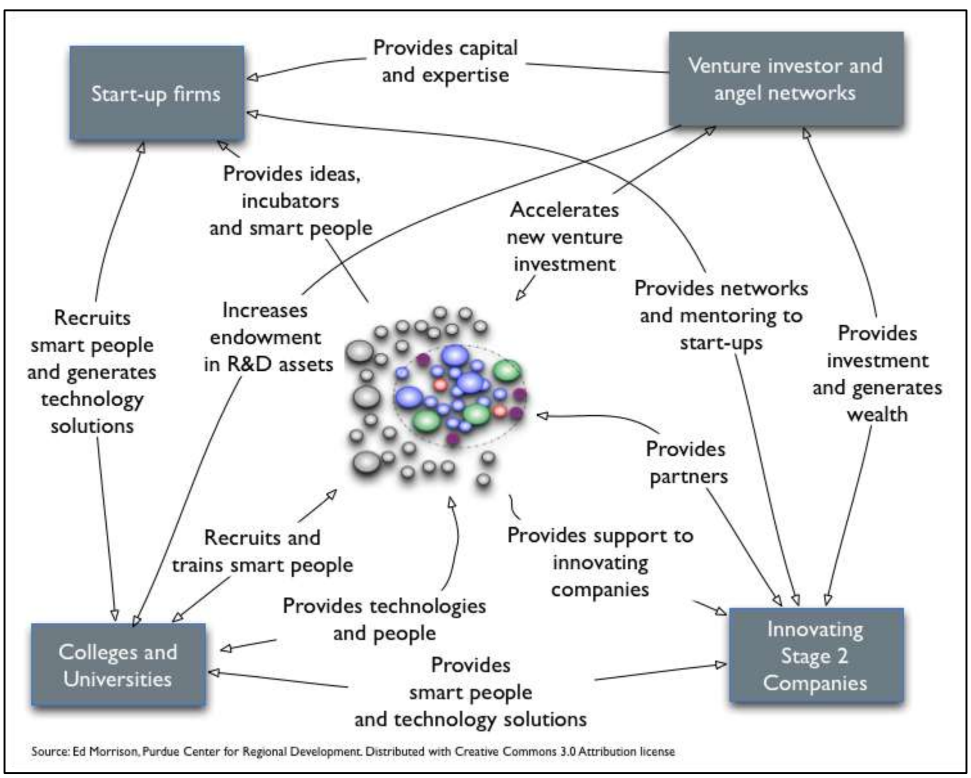
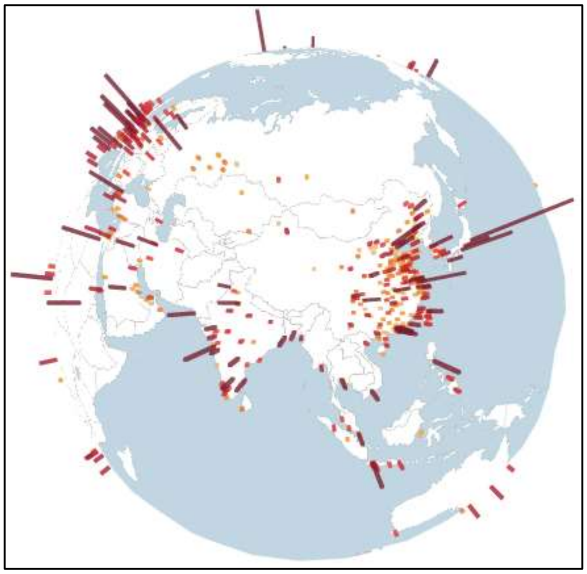
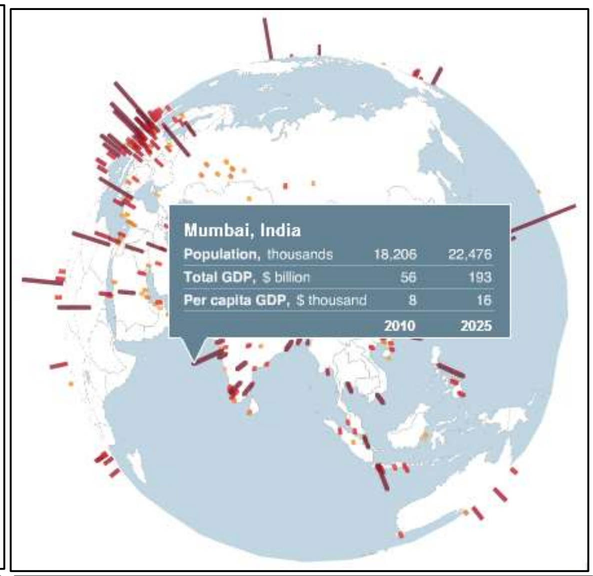


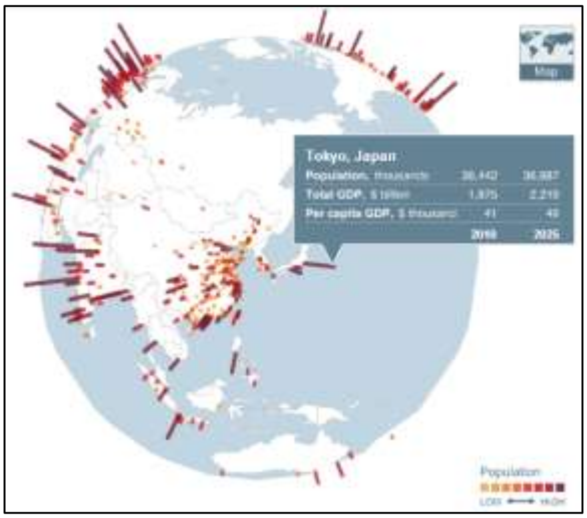
Fig. 2.16: Innovation Cluster [271]

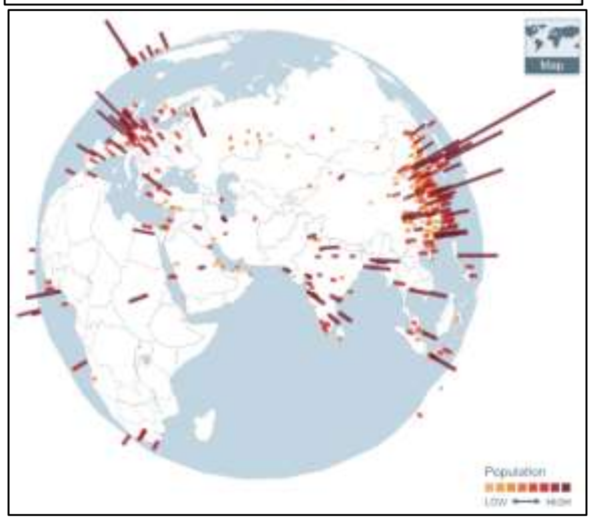
According to a **Map of Global Innovation Clusters** by the **McKinsey Global Institute and World Economic Forum**, some U.S. cities are losing ground to emerging "hot springs" of innovation in Asia and Europe. According to them "Over the next 13 years, **600 cities will account for nearly 65 percent of global GDP growth**. Which of them will contribute the largest number of children or elderly to the world's population? Which will rank among the top 25 cities by per capita GDP? How will regional patterns of growth differ? Explore these questions by browsing through this revised and updated interactive global map below, which contains city-specific highlights from the McKinsey Global Institute's database of more than 2,600 metropolitan areas around the world. You'll see why **growth strategies focused at the country level may fall short in the future**: with new hot spots emerging and household wealth surging in little-known urban centers, companies may have to adopt a much finer-grained approach to tap into the growth that lies ahead." [225] [226]

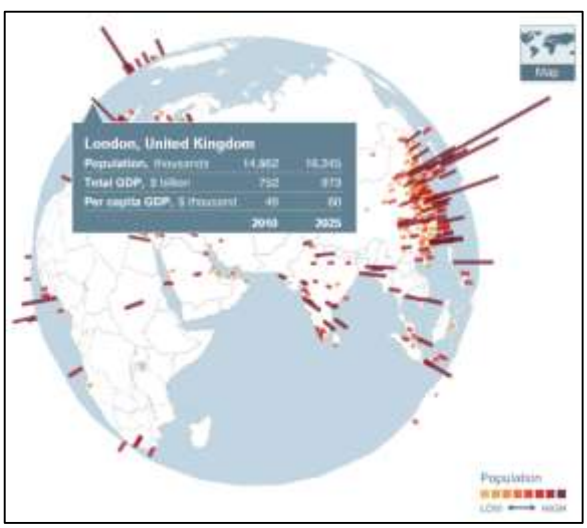
The Map of Global Innovation Clusters by the McKinsey Global Institute and World Economic Forum is very interesting and one must visit the website for exploring more information. [226]

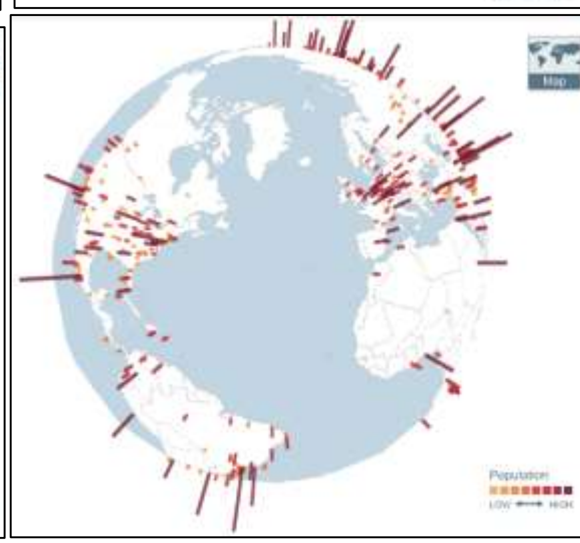



Mumbai, India
Population, thousands 18,206 22,476
Total GDP, $ billion 56 193
Per capita GDP, $ thousand 8 16
2010 2025


Map
Tokyo, Japan
Total GDP,
Per capita GDP,
Population
LOW HIGH


Map
Population
LOW HIGH


Map
London, United Kingdom
Population,
Total GDP,
Per capita GDP,
2010 2025
Population
LOW HIGH


Map
Population
LOW HIGH

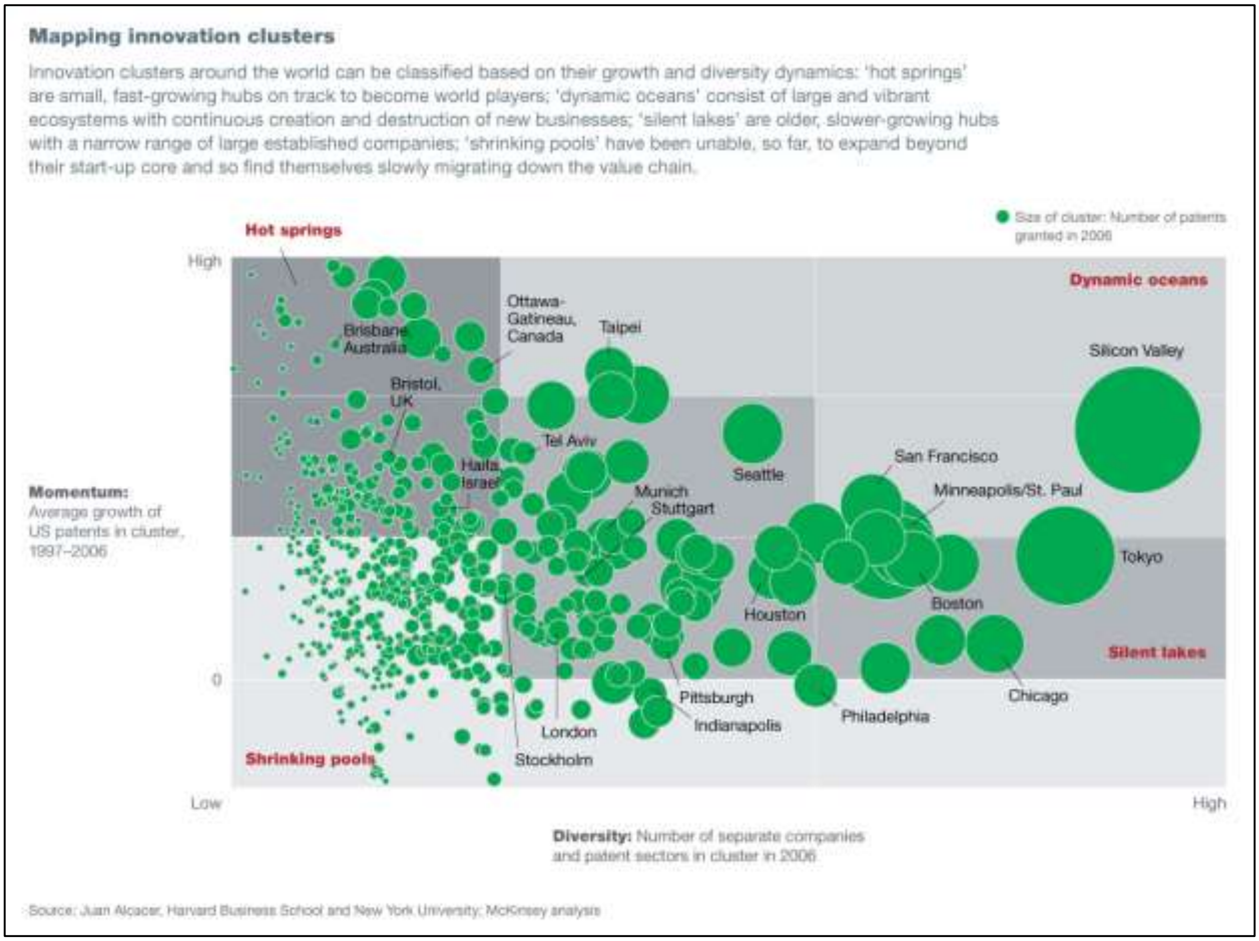


Fig. 2.17: Map of Global Innovation Clusters by the McKinsey Global Institute and World Economic Forum [226] [270]

Industries have a competitive advantage when related companies cluster in a geographical location. Examples are

- Hollywood for movies
- Milan for fashion
- New York for finance
- Silicon Valley for technology entrepreneurship.

The early clusters occurred by happenstance of geography or history. But the theory is that **you can artificially create a cluster** by **concentrating resources, finance and competences to a critical threshold, giving the cluster a decisive sustainable competitive advantage over other places**. Israel, Singapore and now China are the three countries that have successfully put that theory into practice. [221]

Xiangjiang (2013) stated that "the most successful **innovation clusters** are those that combine private and public investment with a public policy commitment to create an active and **open environment where innovation is encouraged**, investments are made and a supportive system can thrive". [187]

Clusters exhibit high levels of innovation and collaboration, often involving direct business interactions with the local research base and the application and commercial exploitation of knowledge and Intellectual Property it has generated. **Clusters reduce the risks associated with developing and commercializing new and emerging technologies, and supporting wider adoption and diffusion**. **Networks develop around clusters involving academics, technologists, skilled workers and investors who develop knowledge and expertise on the strengths and opportunities of new technologies, and on possible risks.** Research undertaken by the European Commission has identified that clusters and regional specialization are associated with higher levels of innovation and prosperity. [224]

> The UK is home to world-leading clusters such as one around **Cambridge**, which is focused on IT and life sciences and has produced significant companies such as ARM Holdings, Autonomy, Cambridge Silicon Radio, as well as many innovative start-ups and early development companies. It also attracts inward investment from companies like Takeda and Pfizer. [224]

> Silicon Valley, greater Boston, San Diego, Austin, Seattle and other U.S. innovation zones for decades have been magnets for the world's brightest and most visionary innovators, technology entrepreneurs, and financiers. Now these hubs face greater competition as places to commercialize new technology and launch new companies. Taipei, Shanghai, Helsinki, Tel Aviv, Hyderabad, Singapore, Sydney, and Suwon, South Korea, are among the many cities that now boast high concentrations of technology entrepreneurs and are launching important companies. [225]

> **Silicon Valley** is an amazing American asset. One of the major factor inputs in Silicon Valley are the **universities and R&D firms**. **Universities are extremely important because one thing in common that every company we visited stated, was the there is a shortage of talent and more available positions than available bodies. Universities, such as Stanford, stand as a double input to the cluster.** Stanford has one of the strongest Computer Science programs in the world and produces excellent talents for the tech industry and they also have a very strong research program. A lot of the people we met while visiting companies, were Stanford alums. That alone establishes connections for new grades to the different companies that are looking for new talent. The other strong input, is the research firms. The research firms partner with a lot of the companies, and help work on research theories or solving problems. [250]

There is evidence that the creation and growth of new, technology-based enterprises occurs most effectively in **geographically-limited clusters**….s. The most famous innovation cluster, of course, is **Silicon Valley**. In such clusters, there is a frequent and strong interaction between many individuals and organizations, on both formal and informal levels. **Science parks** are an attempt to create clusters of like-minded individuals and organizations and to provide them with their basic infrastructure needs. It is difficult to identify the precise building blocks necessary for an effective cluster but certainly many seem to bring together people and institutions involved in business development, finance (and especially venture capital), management, consulting, and research. **Many clusters are built around or near a University campus since this provides both research input and a source of new talent**. [248]

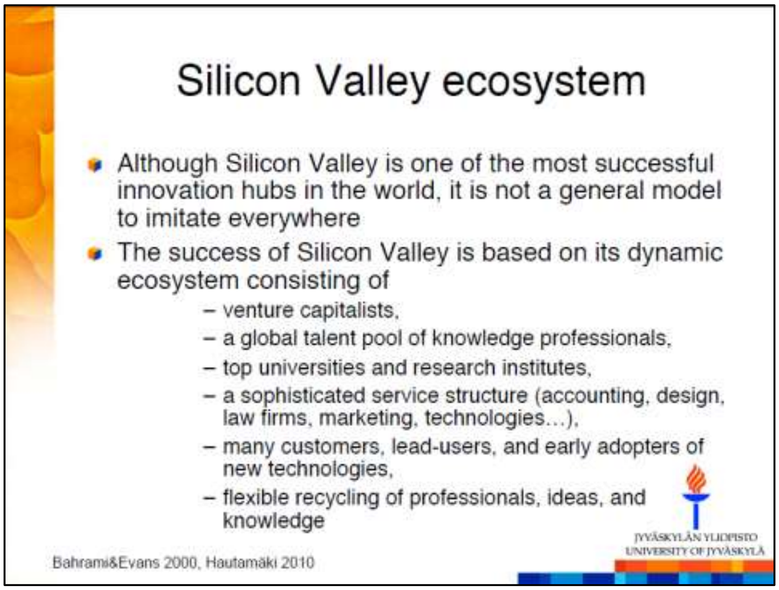


Fig. 2.18: Silicon Valley Innovation Cluster: **Ecosystem concentrated in one region** [218] [223]

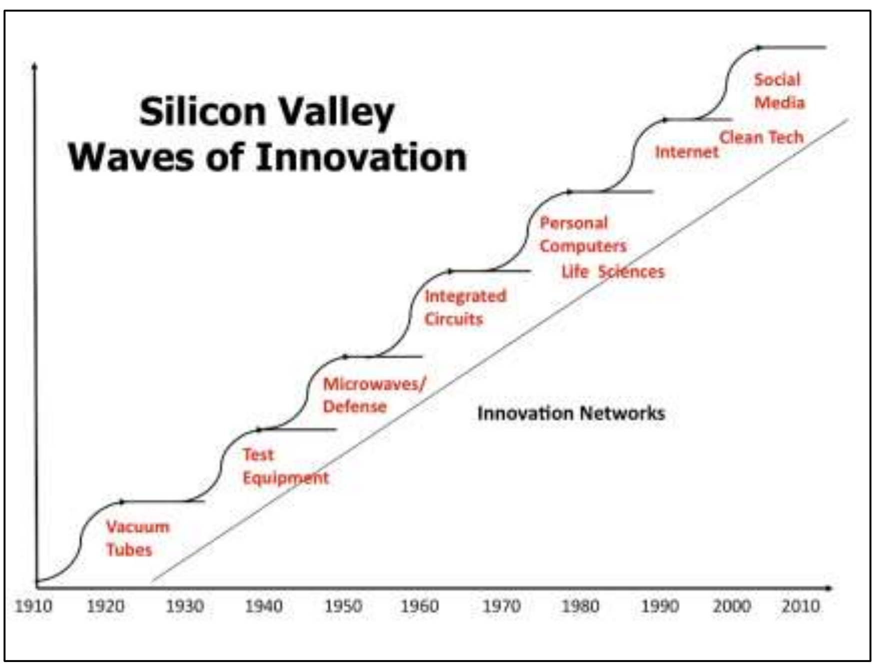


Fig. 2.19: Silicon Valley: Waves of Innovation [333]

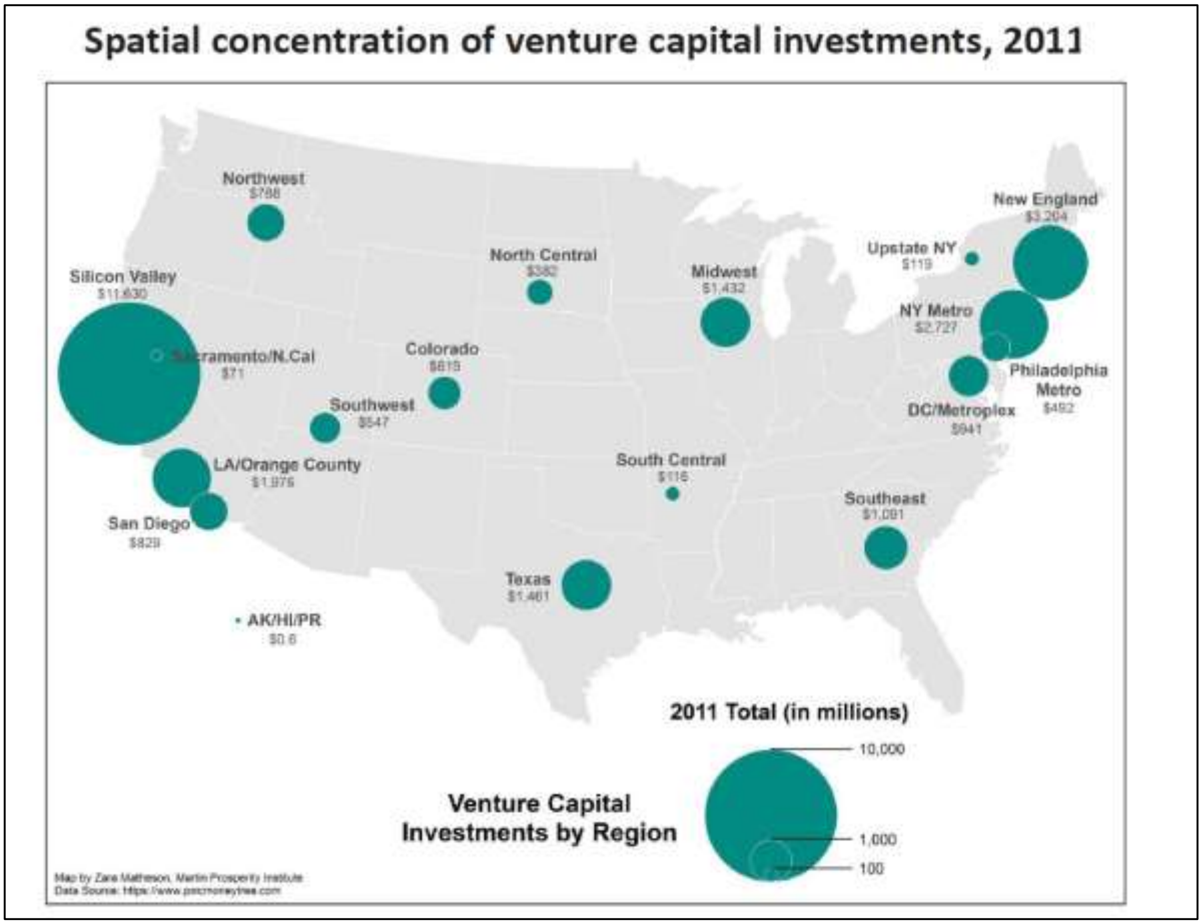


Fig. 2.20: Venture Capital Investment by region (2011): Silicon Valley [249]

The matrix below gives the distances between the 6 top SV icons that I visited.

Distance in Kms between the top silicon valley brands

	Apple	Facebook	Google	Intel	Yahoo	Stanford
Apple	-	24	13	14	14	22
Facebook	24	-	12	24	19	4
Google	13	12	-	14	9	11
Intel	14	24	14	-	9	23
Yahoo	14	19	9	9	-	18
Stanford	22	4	11	23	18	-

Now, what the above table shows is something incredible. **All these guys are located within an hour's drive from each other** - in fact, less than half hour's drive within each other on days without much traffic. Our entire trip to travel to all these places took less than 3 hours!

Fig. 2.21: Silicon Valley: Top 6 Icons located within an hour's drive [247]

Fig. 2.22: Innovation Cluster is pre-requisites for Innovation center [252]

Other nations are getting better at replicating the features that **once made American innovation hubs unique**, such as

- Access to early-stage risk capital
- Strong R&D linkages between universities and business
- Modern science parks, and
- Entrepreneurial support networks. [225]

The best examples of Innovation hubs are:

In Finland, where annual technology exports leapt five-fold between 1992 and 2008, the government agency Tekes invested €343 million ($494 million) in 2009 directly with enterprises—most of them with fewer than 500 employees--developing technologies in partnerships with universities. [225]

Chinese government agencies have mobilized $2.5 billion in venture capital to fund start-ups in the immense Zhangjiang science park outside Shanghai. [225]

Singapore, a fast-growing hub for industries such as biotechnology and digital media, is investing $275 million over five years to establish "enterprise boards" at each university, seed money for venture-capital funds, capital for start-ups, and an incubator for "disruptive innovation." [225]

Figure 1: The Relationship between Innovation and Clustering in Global Sample

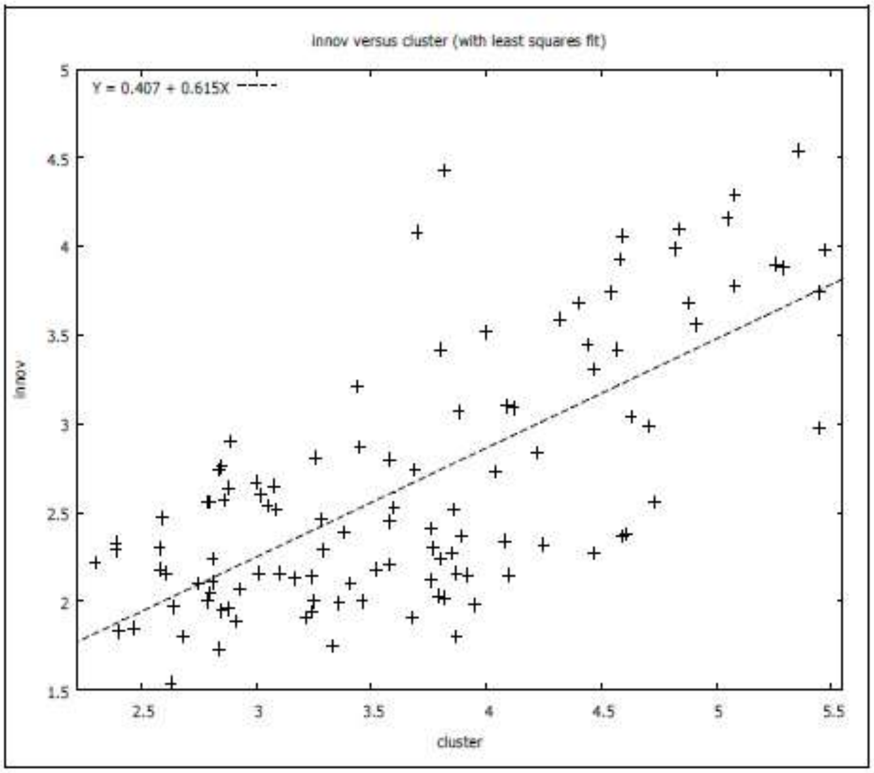


Fig. 2.23: Regression Analysis of Global Innovation Index data: Innovation & Cluster [254]

2.8. Innovation Communities

Innovation Communities: Communities that support innovation have been referred to as Communities of Innovation (CoI)

> Linux: Thousands of talented volunteers, dispersed across organizational and geographical boundaries, collaborate via the Internet to produce a knowledge-intensive, innovative product of high quality namely the Linux kernel

> The Global SAP Co-Innovation Lab (COIL): COIL Network enhances the capabilities of SAP's partner and customer ecosystem through an integrated network of world-wide expertise, and best-in-class technologies and platforms

2.9. Innovation Network

Cooperation pays several times more dividends in knowledge based enterprises because the replication of knowledge costs next to nothing. **Duplication of research leads to lower performance and significant waste of resources**. Hence **global innovation networks try to harness the skills and specializations with a spirit of global cooperation to the mutual benefits of all partners**. According to a study in Sweden, The odds getting a patent application approved are in the range 1.1 to 1.5 times better if an application is a result from research collaboration. Proper implementation of Intellectual Property Rights and agreements will lead to a development of trust and discourage free-riders…Globalization has led to higher competitions, in which competitors quickly imitate sources of competitive advantage. Hence, it becomes necessary for companies to successfully innovate on a sustained basis. Advanced Information and Communication Technologies (ICT) have made it feasible for companies to collaborate and do Globally Distributed Work (GDW). [576]

Disruptive innovations are not a result of a single technology invented by a few people but a combination of various innovations along the entire spectrum (idea generation to consumption) thus making it **necessary to collaborate**. The framework of 'Innovation Network' is perhaps the only sustainable way to deliver innovation in today's environment. Innovation networks as a concept is not completely new. Typically it has been the technology delivery entity, e.g. Microsoft, IBM driven innovation networks, or the research entity, e.g. Gartner, Google driven innovation networks that has been controlling the network and thus being the principle beneficiary. [576]

2.10. Drivers of Innovation

Economists understand that **innovation drives economic growth**. Big innovations based on harnessing steam power, discovering electricity, the computer revolution all have spurred economic growth. **But what drives innovation?** [313]

In 2012, the FICCI has published a report on "Innovation readiness of Indian SMEs - Issues and challenges". This interesting report have mentioned the following major factors, which can affect firm's capacity to innovate:

- The location of the firm within or close to a major urban area and thus in greater proximity to sources of new knowledge and ease in participating in knowledge flows.
- Educational level of the Owner/CEO/Manager, especially a degree from a technical university or engineering program that stimulates and facilitates problem solving.
- Global exposure through training, work or study abroad which opens opportunities for networking for knowledge flows and collaboration and creates an awareness of the utility to do so.
- Ownership structure of the firm, which influences the choice of products and processes as well as their subsequent modification or change.
- The firm's sector, which provides a measure of the stimulus to innovation resulting from the higher R&D intensity of the sector and nature of competition within the sector.

- The size of the firm, which is related to its access to resources to and opportunities for knowledge scanning to support a process of innovation.
- Exports (as a percentage of sales) and whether this is rising as an indicator of the firm's competitive interests and abilities.
- Habits and practices of innovation as reflected in having innovated previously [404]

SN	Drivers of Innovations
1.	Bottleneck
2.	Budget cuts
3.	Changes in the exchange rate
4.	Constraint Driven Innovation
5.	Customer demands / requirements
6.	Demographic, social and market changes
7.	Economic climate
8.	Enabling and platform technologies
9.	Enhancing convenience to use (ergonomic considerations)
10.	Enhancing ease in manufacturing
11.	Financial pressures to increase efficiency
12.	Financial pressures to reduce costs
13.	For controlling and reducing process wastage
14.	For controlling and reducing work in process inventories
15.	For ensuring timely deliveries
16.	For improving ease in manufacturing
17.	For improving process efficiency
18.	For improving productivity
19.	For reducing health hazards and improving safety of workforce
20.	For reducing processing costs
21.	For reducing processing time
22.	Geopolitical culture
23.	Globalization
24.	High costs of service delivery
25.	Improving product reliability
26.	Improving quality
27.	Increased competition
28.	Increased demand for accountability
29.	Individual, Team, Enterprise
30.	Industry and community needs for sustainable development
31.	Industry trends
32.	Intelligence systems
33.	Investment attraction
34.	Knowledge Management, Learning Resource Centers and Libraries
35.	Limited access to resources
36.	Maintaining technological leadership
37.	Major projects
38.	Market conditions
39.	Motivator
40.	Need of more functions / attributes
41.	Opportunity Driven Innovation
42.	Organizational culture
43.	Physical environment
44.	Problem Driven Innovation

45.	Processes
46.	Psychological climate
47.	Reducing processing and manufacturing costs
48.	Research and development
49.	Rising customer expectations regarding service and quality
50.	Shorter product life cycles
51.	Standardization and simplification efforts in an organization. --- Simplification aims at reducing product complexity and Standardization seeks manufacture of standardized products and dropping what is unnecessary or superfluous.
52.	Stricter regulation
53.	Sustaining competitiveness
54.	Talent
55.	Tapping new markets or market segments
56.	Technological opportunities, Technological advancements and progress
57.	To increase the saleability (appearance etc.)
58.	Unsatisfactory processing time
59.	User as a Innovator
60.	Value migration

Table 2.1: Drivers of Innovations [258] [259] [260] [263] [284]

2.10.1. Motivators

According to Clifton, four types of people drive innovation: inventors, entrepreneurs, extreme individual achievers in their fields (such as the arts, entertainment, or sports), and super mentors. Let's not forget that creativity needs action to become innovation. Companies must do more with their employees' creativity than just acknowledging that an employee has a good idea. That's why managers matter. Looking at the four categories of innovators, often the inventors, entrepreneurs, and high achievers would be nothing without that last category: super mentors, Clifton said. "When it comes to innovation, mentors play a key role, because they're the people who say, 'That's a great idea. You can make a lucrative business of that,'" Clifton said. Super mentors inspire their protégés and help them connect with the people who can couple action with their ideas -- as some of the best managers do. [258]

2.10.2. Economic Climate / Market Conditions

The spot where innovation culture is easiest to maintain is when market conditions are such that there is not too much fear, or too much confidence. These are rare moments in the business cycle. Want to see innovation dry up and fade away? Announce a layoff/cutback/restructuring. Want to see people start to play it safe and stop putting things at risk? Let people know that sales are down, or that the economy is in the tank. Similarly, announce market dominance, the best year ever, or give a big bonus. People can get complacent. The smart innovation leader sets money aside to support experimentation when the market is down, and requires (creating real accountability as well) ever increasing innovative output when things are running really well. Paradoxically, research shows most organizations only get radically innovative when they are in “distress situations.” When there’s no other choice, that’s when people start really changing things up.

2.10.3. Profit, Market & Legal Drivers

2.10.3.1. Profit Related Drivers

- Customer demands: the drive to meet consumer expectations are common drivers of innovation. Companies increasingly need to respond to consumer buying decisions which can be influenced by such factors as fashion, convenience, indulgence, functionality and 'conscientious consumerism'. Innovation projects often begin with what the consumer wants or needs, rather than as a consequence of research and development.
- Competition: the need to differentiate one's product or service from the competition often results in process, product, packaging and/or supply chain innovations.
- Research and development: a stable and well-funded base for building knowledge and capabilities, will in turn result in the development of new, more advanced and more profitable services and products. The ability of manufacturers to access research and technological developments is crucial to driving innovation, as is disseminating enabling technologies that support production flexibility.
- Enabling and platform technologies: major advances in enabling and platform technologies have opened up opportunities for new products and services, and operational efficiencies. [260]

2.10.3.2. Market Related Drivers

- Major projects: awarding major projects to companies in NSW attracts new investment and drives innovation by suppliers and contractors
- Investment attraction: attracting global companies that bring new technologies and innovative labor skills
- Globalization: The globalization increases levels of competition, drives the application of best practice and brings overseas investment into Australian markets
- Industry trends: trends which occur in a local market or globally, have a significant impact on how business is carried out and how businesses plan for the future. [260]

2.10.3.3. Legal Drivers

Regulations: these drivers can take the form of environmental, security and safety regulations, amongst others. For example, across sectors, the regulations associated with occupational health and safety issues have led to innovations which have improved safety in workplaces. [260]

2.10.4. Problems, Constraints and Opportunities Drivers

The possible drivers for innovation can be classified into three categories, **problems, constraints and opportunities.** [263]

2.10.4.1. Problem-Driven Innovation

Innovation driven by a problem (e.g., a bottleneck, an unsatisfactory processing time, high costs of service delivery) is the classical case where a novel, value-add contribution is sought in reaction to an identified issue. In process terms, we could call this the classical process improvement scenario. An identified concern with the status quo is described in so-called as-is models, it is located in the Enterprise Architecture and a set of well-defined analyses techniques (e.g., lean management, Six Sigma, theory of constraints) are deployed by qualified business analysts. Various facilitation techniques, common practices as materialized in reference models (e.g., SCOR) and brainstorming-like facilitation techniques are then used to develop a to-be scenario that (hopefully) eradicates the problem. [263]

Problem-driven innovation can be characterized as reactive and reliant on the problem to manifest and to be perceived. If the problems to be addressed outweigh the organizational capacity to respond, the focus will be on firefighting leaving little room for considering proactive innovation. Problem-driven innovation tends to be transactional (process) innovation as new products, services or even business models are typically not derived from an attempt to fix an issue. [263]

Examples for problem-driven innovation are:

- Using electronic signatures to avoid paper consumption in administrative processes (problem: lack of sustainability);
- Implementing a problem management database to deal with recurring incidents (knowledge management problem);
- Outsourcing the IT helpdesk to an external provider (process/financial problem). [263]

Problem-driven, core innovation is well-understood within the BPM and EA community and at least in the phases of problem definition and analysis, not so much in the generation of an appropriate response, well supported by a wide range of well-documented methods, tools and techniques. Problem or issue registers are used to characterize (e.g., severity, owner, milestone) and monitor the problem resolution. [263]

Successful problem-driven innovation ultimately overcomes the problem and its impact can be measured by the extent to which this problem caused issues. However, in most cases it can be expected that involved stakeholders will be rather relieved than excited about the impact this innovation will have on their organization. [263]

2.10.4.2. Constraint-Driven Innovation

Innovation driven by a constraint describes cases in which boundaries exist within the context of an organization that limit the ability to undertake “regular” routines. Instead, a constraint within the context ‘forces’ the organization to identify and adopt novel ways of running its business processes, or sparks novel product or service designs. These constraints can me macro-economic developments (e.g., changes in the exchange rate making export or import more difficult) or company-internal development (e.g., budget cuts). Unlike problems, constraints cannot be eliminated, but an organization has to adopt to these constraints. [263]

Though constraints mean restrictions they can be an inspirational source for innovation as they put pressure on an organization. Organizations with constraints have the potential to be more innovative than those without if they convert the need to adopt into a constructive and successful innovation process. As a response the concept of reverse innovation (aka trickle-up innovation) has emerged. In these cases organizations are going overseas in a search for constraints that they cannot find at home. Once the innovation took place overseas, they bring this innovation back into their home country. [263]

Examples for constraint-driven innovation are

- The development of the mobile banking system M-PESA that was successfully deployed in Kenia as an innovative response to the limited access to banking infrastructure (constraint);
- The virtual store of TESCO in South Korea, an innovation that facilitates retail shopping for time-constrained customers at public transport hubs using a solution consisting of smart phones, QR-scanning and home-delivery logistics;
- The sophistication of cheque processing systems in the Brazilian banking system, a response to the previous hyper-inflation (constraint) that enforced fast processing of financial transactions. [263]

Constraint-driven innovation demands a context-aware organization that understands its environmental setting and internal operations. Context-aware organizations do not only understand what context matters, but also how it matters to their organizational systems, Enterprise Architecture and business processes. In other words, they are able to relate elements in the context (such as stability of the financial system, geographical dispersion of markets, weather patterns etc.) to elements in their organizational systems (technical architecture, product and service models, processes, workforce, etc.) and thus have an understanding of impacts, barriers – and potential solutions. [263]

2.10.4.3. Opportunity-Driven Innovation

Innovation driven by an opportunity describes cases in which innovations are borne not out of necessity but out of the realization of a possibility. Here an understanding emerges that some advancement within or outside the organization can lead to the emergence and development of an innovation. Unlike the reactive forms of problem and constraint-driven innovation, opportunity-driven innovation is proactive and in many cases an option and not a necessity. [263]

This form of innovation requires translating the affordances of specific technological opportunities (e.g., social media, mobile application, RFID) or other opportunities (e.g., usage-based pricing, commercialization of idle resources) into capabilities. Social media, for example, provides the capability to broadcast and to democratize information and processes (“everyone participates”). These capabilities need to be studied in terms of their relevance or even disruptive potential for an organization (see social media activities of organizations such as Burberry or Best Buy). [263]

Examples for opportunity-driven innovation are

- The Kaching application of the Commonwealth Bank of Australia which allows users to transfer funds from their smartphones within their FaceBook network improving the convenience of its services for retail banking customers;
- Curtis Kimbell, owner of Creme Brulee Cart in San Francisco, who uses Twitter to make his very own sales process more location sensitive by tweeting his current location to his nearly 22,000 followers;
- Electronic collars on cattle monitored via satellite allow to control straying cattle by sending a mild electric shock when they leave the defined perimeter, a showcase example for emerging national broadband networks. [263]

These innovations rely on the creativity to convert new capabilities (e.g., the ability to inform 1,000s of 'followers') into a value proposition for the own organization (e.g., a cost effective way to inform potential clients about the proximity of a mobile sales cart). Opportunity-driven innovation occurs when an organization understands how to capitalize on such emerging affordances. The more the opportunity matures, the more risk-averse organizations will start to adopt it. As such, opportunity-driven is in comparison with problem-driven or constraint-driven innovation the type of innovation with the highest potential for disruption. [263]

Opportunity-driven innovation is characterized by the attributes of innovation capability and innovation latency. Innovation capability refers to the potential of emerging technologies to spark innovation in an organization on basis of their affordances. The question is what new capability is provided by a technology that could yield novel ways of working, products or service models in an organization. A typical example is the capability of mobile technologies to provide location-based information – which can provide the 'ability to locate' to organizations. Whether or not this potential is realized then is a question of innovation latency – the time required by organizations to identify the innovation capability of an emerging technology (data latency), the time required to analyze the innovation potential originating from that capability (analysis latency) and finally the time required to reach a decision about capitalizing on that innovation potential (decision latency). [263]

2.10.5. Intelligence, Technology, People, Customer, Rational, Social, Emotional & Environment Drivers

- Intelligence drivers - so much today is swirling around, often unsettling and changing. We don't have long periods of stability anymore and to offset this we need to revert to often artificial intelligence to 'read, sense and be more interpretative' of these constant shifting patterns. We need ways to make sense of often disparate flows that piece together in different ways, difficult to initially see, so as to provide insights that can open up our thinking to new innovation. Cognition refers to a faculty for the processing of information, applying knowledge, and changing preferences that allows for development into concepts; individual minds, groups, and organizations need to pick up and explore this driver far more for innovation. [284]
- Technology drivers - The world of external collaboration, leveraging our personal and group networks and the different ways to interacting, are challenging organizations significantly. We all need to open up in areas where internal intellectual property, heavily guarded in the past, is

being exposed to a different scrutiny. Technology needs revisiting to accommodate a new diversity of opinion that extracts value in new more open ways. Also the management of physical and virtual relationships is also needing dramatic change in our behaviors and trust. We need fresh frameworks and designing these into our technology solutions for allowing open thinking. Much of this will come from the management of technology and the new understanding of the needs to capture, translate and extract in new ways. Getting the technology balance right and you open up to innovation in such an unparalleled way than in the past. Technology understanding will influence innovation and drive it in some dramatic ways in the future. [284]

- People drivers - "Our people make innovation work, they drive it". This is heard increasingly yet our actions run contrary to this so many times. We need to look at what drives people to rise to new heights and performances within themselves? It is getting the mix right- in creativity, in talent, through diversity of opinion, exploring dialogues and having a constant focus on building relationships; it is providing them something in return for 'driving' innovation. Keeping people and not shedding them when it suites immediate needs and your bottom line must become a thing of the past, simply as less people are entering the work force with the more experienced ones leaving more than ever for multiple reasons. This means we must treat people as an increasing valuable asset that needs to be prized very highly not in ways that fitted 20th century practices when supply was plentiful. Keeping experience within organizations is a growing challenge. We also need to value our middle managers more, give them empowerment not more restrictions. You lose someone or sometimes many simply at one go, and you lose their relationships, their sets of experiences that cannot be easily replaced. You through away an incredible investment. Can we afford to keep managing in this way? No, I don't think so, people are driving innovation more and more and if organizations don't stop these current practices of reducing headcount to meet short term numbers, they will lose one of the richest drivers of innovation, their people, and nothing else can make up for this loss in managing innovation. [284]
- Customer drivers - Marketing needs to do a significant 'reset' as customers shift from price, lower volume demand and seek increased value and personal engagement. Getting into the mind of your customer, understanding their unmet needs and then interpret these into new innovation solutions is tougher than ever. As organizations expand globally there is going to be a need for far more reverse engineering innovation to match need with product or service in these times of diminishing income. Customers are driving innovation more than ever and organizations are presently struggling to catch up and master the new dynamics of the customer and the economics of the markets. Innovation for and with less is very relevant today. Same as knowing customers real needs. [284]
- Rational drivers - Innovation needs greater process and rational innovation thinking. This will come from a greater focus on innovations strategic architecture, the management of the systems to 'drive' innovation through to commercialization, the innovation process designed on shrinking the time line, increased productivity and interventions so to enable successful movement towards this commercialization. We need to advance execution and results from this activity and that needs us to approach innovation in a more rational way to get consistent results. [284]
- Social drivers - How we are engaging in the world around us are one of the challenges we need to resolve. Interactions that can transmit genuine desire for the good, which are seen as enduring and meaningful to the lives of people, are going to be valued. Thinking these through,

then implementing these in careful, thoughtful ways is going to be critical to growing innovation in social responsible ways that are meaningful for the communities and on a personal level will provide a completely new avenue to innovation activity. [284]

- Emotional drivers - We need to gain permission to enter people's lives. We need to learn, to create, to explore people's dreams, desires and hopes. Exploring the eight fundamental human emotional drivers of (1) connection and sense of self, (2) maintain security over our lives, (3) wanting more diversity, seeking variety, (4) achieving recognition and significance to grow beyond the present, (5) having a sense of achievement and progress, (6) opportunities for challenges and personal growth, (7) achieving self-satisfaction and pride in what we do and finally (8) the wish to contribute and be responsible. Mastering this set of emotional drivers through different innovation activity can be very powerful. [284]
- Environment drivers - the culture and climates provided that we operate within can allow or deny innovation. There is a growing need to increase co-operation between the diverse aspects of innovation activity and other organizations on third party platforms so as to involve as diverse a group as possible. We need to consider the organizations complete value chain and its diverse networks across the whole organization, than in the present silo form of present open innovation thinking (just R&D departments for instance). There is a difficult choice to make between quick results, always needed, and longer term structures to ensure sustaining innovation on a broader platform. Innovation is increasingly driving sustainable society in new products, processes and organization designs. Environment has to date seldom been an explicit targeted comprehensive process for many in innovation activity. It has been experimental. Increased attention to understanding the broader environment we operate within, how finite and sometimes fragile it is, will play a greater role for innovation development. The effectiveness in addressing environment problems will drive innovation significantly in the years ahead. [284]

2.10.6. Product, Process Innovation Drivers

- Product innovation – Drivers of change: Reasons for Change in Product Design / Product Redesign
    - Change in customer requirements
    - Adding more functions / attributes
    - Increasing saleability (appearance etc.)
    - Enhancing ease in manufacturing
    - Tapping new markets or market segments
    - Increasing product's life cycle
    - Enhancing convenience to use (ergonomic considerations)
    - Technological advancements and progress
    - Standardization and simplification efforts in an organization. --- Simplification aims at reducing product complexity and Standardization seeks manufacture of standardized products and dropping what is unnecessary or superfluous.
    - Improving quality
    - Improving product reliability
    - Maintaining technological leadership
    - Reducing processing and manufacturing costs
    - Gaining competitive edge

    - Sustaining competitiveness
- Process innovation –Drivers of change: Factors Necessitating Change in Process Design / Process Redesign
    - For controlling and reducing process wastage
    - For improving quality of output
    - For controlling and reducing work in process inventories
    - For reducing processing time
    - For reducing processing costs
    - For improving process efficiency
    - For improving productivity
    - For improving ease in manufacturing
    - For ensuring timely deliveries
    - For reducing health hazards and improving safety of workforce
    - May be thrust upon / forced by
    - Changes in product design
    - Overall technological advancement / progress
    - Gaining competitive edge
    - Sustaining competitiveness

FIGURE 1

Cultural Drivers of Innovation

Leveraging Diversity of Thought	Openness to new ideas and different perspectives
Positive Supervisor Relations	Respect in and trust of one's immediate boss
Collaboration and Teamwork	Benefiting from teamwork and group effort
Supporting for Risk Taking	Willingness to take prudent risks, tolerate failure
Bias for Action	A tendency to decide and move quickly
Flexible Work Arrangements	Allowing for non-standard working hours
Leadership	Credible and decisive leadership
Stimulating Environment (interpersonal)	Lively, active discourse with well-respected peers
Effective Information Sharing/Warehousing	Easy access and open sharing of critical information
Anticipating/Driving Future Customer Needs	Always remaining close to the customer's needs
Stimulating Environment (physical)	Tools to support innovation, e.g., work space, software
Rewarding Innovation	Recognizing and compensating those who contribute

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Fig. 2.24: Cultural Drivers of Innovation [318]

It’s not unusual that great innovations start based on industrial needs and then develop into something ordinary people can use in their daily lives. SMS is one example. At first, it was used for telecom-service engineers to communicate between themselves so as not to overload the newly developed GSM network. GPS is another, which started as a military application that answered a very precise need to find a specific location. It was then further developed, to help a unit find its own location. Today, it has changed our lives to the extent that all we need is a vague idea of our destination and the GPS can guide us to basically anything:

- During busy traffic hours, the GPS will guide you to a shortcut.
- If you are off on vacation to a place you’ve never been before, the GPS will guide you to restaurants, museums, and the best beach.
- If you have had a late night out or you are just lost, GPS shoes will guide you home. [672]

2.11. Innovation Management

Matthew Ganz, Vice President and General Manager of Research and Technology at the Boeing Company stated that “If you have a creative idea and it doesn’t create value, it’s not technology. It’s art. If you’re all about value creation with no creativity, the accountants are going to take over. You need to prime the pump with creative ideas, and then you need to have **rigorous processes in place to turn those ideas into dollars**.” [601]

Innovation management is the **management of innovation processes**. It refers both to product and organizational innovation. Innovation management **includes a set of tools** that allow managers and engineers to cooperate with a common understanding of processes and goals. Innovation management allows the organization to respond to external or internal opportunities, and use its creativity to introduce new ideas, processes or products. It is **not relegated to R&D**; it involves workers at every level in contributing creatively to a company's product development, manufacturing and marketing. [274]

By utilizing **innovation management tools**, management can trigger and deploy the creative capabilities of the work force for the continuous development of a company. Common tools include

- Brainstorming
- Virtual prototyping
- Product lifecycle management
- Idea management
- TRIZ (Russian Technique)
- Phase–gate model
- Project management
- Product line planning

- Portfolio management

The process can be viewed as an evolutionary integration of organization, technology and market by iterating series of activities: search, select, implement and capture. Innovation processes can either be pushed or pulled through development. A **pushed process** is based on existing or newly invented technology, that the organization has access to, and tries to find profitable applications for. A **pulled process** is based on finding areas where customer's needs are not met, and then find solutions to those needs. To succeed with either method, an understanding of both the market and the technical problems are needed. By creating multi-functional development teams, containing both engineers and marketers, both dimensions can be solved. The product lifecycle of products is getting shorter because of increased competition. This forces companies to reduce the time to market. **Innovation managers must therefore decrease development time, without sacrificing quality or meeting the needs of the market**. [274]

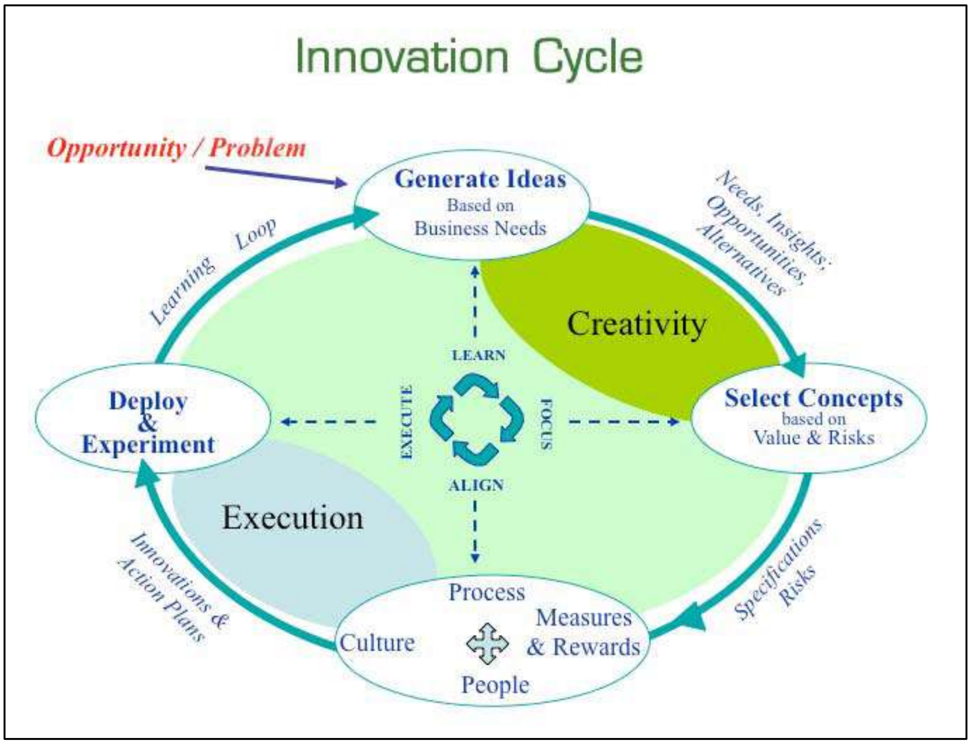


Fig. 2.25: Innovation Cycle [17]

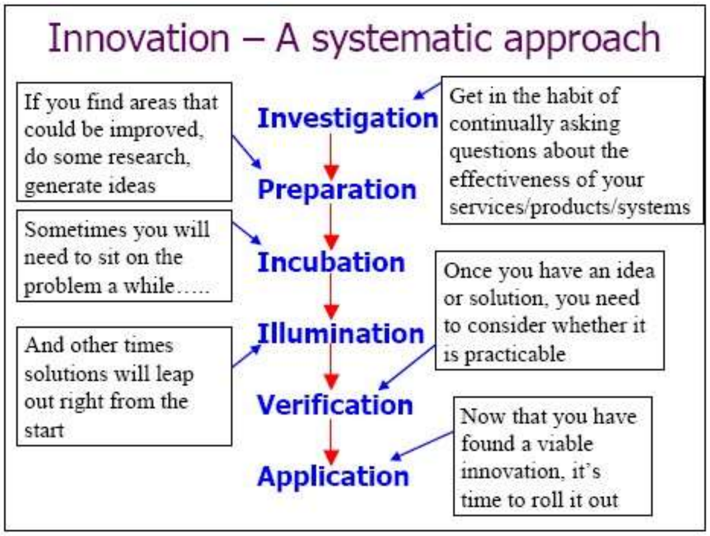


Fig. 2.56: Innovation: A Systematic Approach [18]

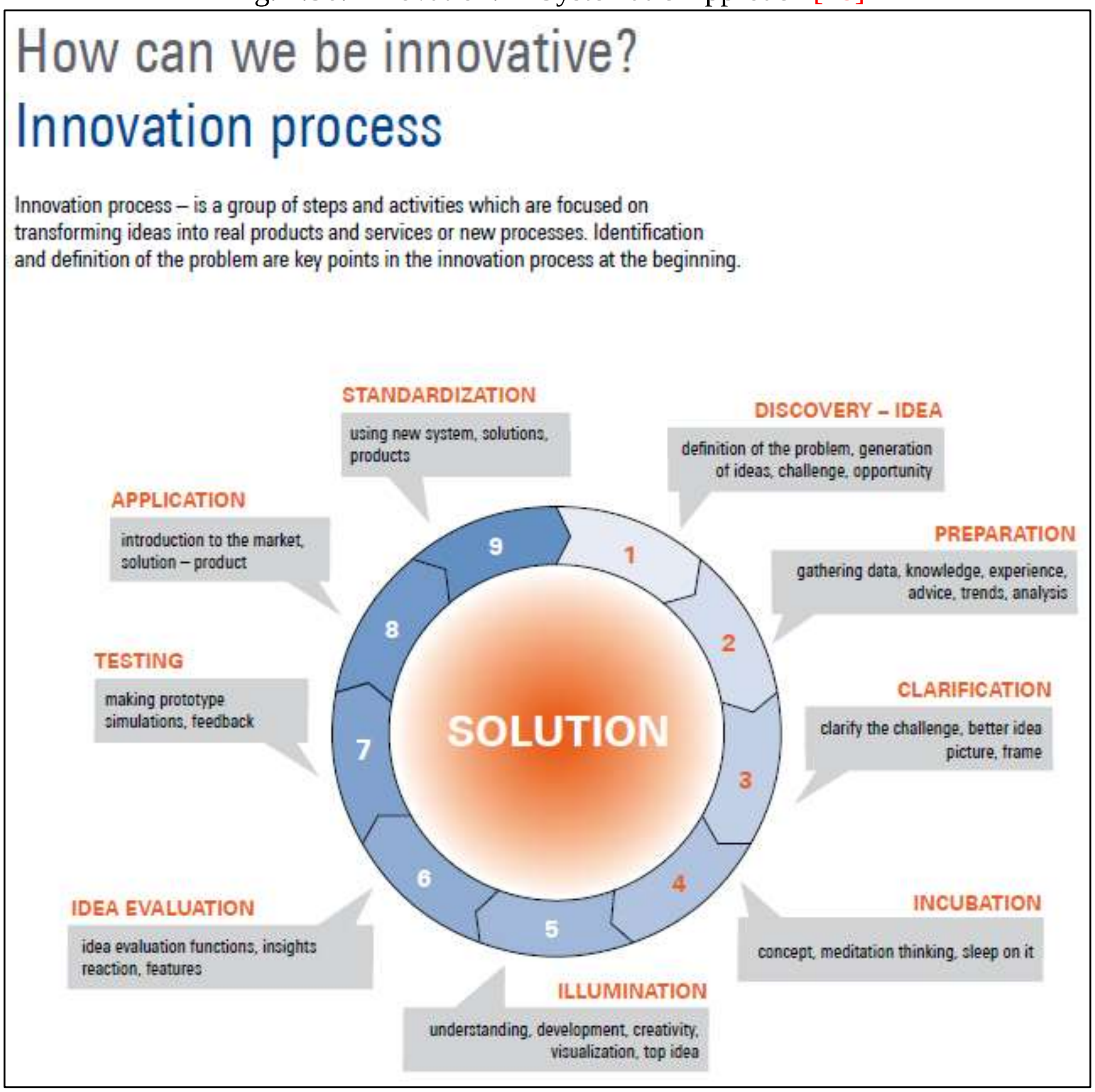


Fig. 2.27: KPMG Report: Innovation Process [14]

Chapter 3: Case Studies

*Apple understands that **competition isn't device versus device**, it's **ecosystem versus ecosystem.** [628]*

*There is today an emerging distinction between "leadership" and "**innovation leadership**," a new vision of what it takes to become an innovative leader and a leader of innovation. This new model of thinking requires a new way of preparing leaders, and a new way of thinking about leadership. The rules are changing and it might not be stretching the point to say there is actually a leadership revolution brewing. [642]*

Very little has been written on Innovation Leaders, those individuals who lead a new product or service through ideation, design, development, market launch and implementation. These Innovation Leaders will be the catalyst for change by bringing diverse parts of the organization together to launch new products and services. [11]

3.1. Business Model Innovation Case Studies

The article by IFM, University of Cambridge stated that "Competitive pressures are pushing business model innovation ever higher up companies' 'to do' lists. While the concept has been around for a long time, it has come increasingly to the fore over the last 15 years as the pace of globalization and technological change and shifts in industry borders have all created opportunities for new business models. The importance of business model innovation was confirmed by a survey of 700 CEOs worldwide carried out by IBM in 2008 which showed that those firms with the fastest-growing operating margins were placing **twice as much emphasis on business model innovation** as those which were under-performing. **New business models have shown themselves to be particularly effective for commercializing scientific innovations (important for countries like India with its large scientific community), creating strategic flexibility and reducing the costs of products and services in less affluent societies**. Achieving these outcomes through **business model innovation is much harder for other firms to copy than product or process innovations and can therefore deliver greater competitive advantage**. In emerging economies, business innovation has been instrumental in delivering more efficient services in key areas such as health care, energy provision, food security and nutrition." [556]

3.1.1. Aravind Eye Clinics

3.1.1.1. Growth Story of Aravind Eye Care Clinics:

Fig. 3.1: Aravind Eye Care System [493]

- 1977- First 30 Bed Hospital opened at Madurai, the third largest city in Tamil Nadu
- 1978- 70 Bed Hospital, exclusively for free patients
- 1981- Existing paying hospital building expanded to 250 beds and 80,000 sq. ft. of space over five floors
- 1984- A new 350-bed hospital opened exclusively for free patients in Madurai
- 1985- 100-bed hospital at Theni, a small town 80 km west of Madurai
- 1988- 400-bed hospital at Tirunelveli,160 km south of Madurai
- 1997- 874-bed hospital at Coimbatore
- 2003- 750-bed hospital at Pondicherry
- 2011- 150-bed hospital at Salem [544]

3.1.1.2. Awards and Recognitions

- Conrad N. Hilton Humanitarian Prize in 2010
- 2008 Gates Award for Global Health
- India’s Most Innovative Hospital Award at India Healthcare Awards 2011
- FICCI award for the Best Private Hospital in India [544]

3.1.1.3. No Age Limit to Entrepreneurship

Back in 1976 the head of the Department of Ophthalmology at the Government Medical College in Madurai, Dr. G. Venkataswamy, retired. Dr. V (as he is popularly referred to) had worked for many years on providing eye care – eye tests, glasses, cataract operations, etc. – in rural communities and rather than give this up and potter around his garden he decided to use his retirement time to carry the work on. **He provides an excellent example of the principle that there is no age limit to entrepreneurship** – the key is passion, energy, enthusiasm and a clear sense of what he wanted to achieve. In his case it was nothing less than eliminating unnecessary blindness in his home state of Tamil Nadu – and perhaps after that, across India itself. [492] [494]

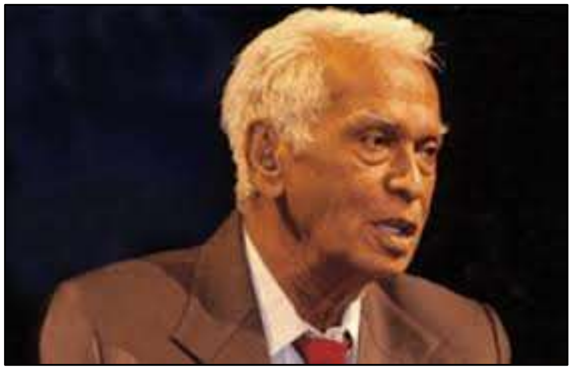


Fig. 3.2: Dr. G. Venkataswamy

3.1.1.4. Inspiration from McDonalds

The innovation challenge here is significant – how to carry out a high quality process at low cost? But it also reminds us of a key principle – whilst different sectors may appear to have little in common, there is often a rich opportunity to learn across these worlds. Dr. V. looked long and hard at other fields where the same challenge of carrying out activities systematically, reproducibly and to a high quality standard – but at low cost – and eventually developed a new approach to the eye care problem. He found inspiration in McDonalds, the fast food company which has managed to spread its golden-arched empire across the planet based on systematic, high volume production of a range of meals offered at low cost. Central to their success is the idea of reproducibility – despite huge variations in the context in which they are located, all McDonalds outlets operate on the same model, and staff are trained in a core set of skills which are common to all its operations. It's a model which the Croc brothers developed back in the 1950s - but one that was borrowed from an earlier exponent, Henry Ford. When he and his team of skilled engineers were setting up the business back in the early 1900s they faced the same challenge – how to make a complex product (the Model T Ford) systematically and reliably but at a low enough price that it could become 'a car for Everyman'? Their solution was to design a system which standardized as much of the process as possible and reduce the key skills and discretionary elements to a minimum – and then apply this across a high volume of production. In turn these ideas weren't new – the principles of division of labor go right back to the 18th century and the observations of Adam Smith on pin-making in the early days of the UK's factory system – but they represent a powerful model which Dr. V. was able to adapt. [492] [494]

3.1.1.5. High Volume

The basis of the Aravind eye clinics is standardization and 'engineering' cataract surgery for high volume production. He opened his first hospital in 1977 with 30 beds and managed to generate a surplus in the first year of work so that a second 70 bed hospital could be opened catering exclusively to the poor and offering operations free of charge. In 1981 a fee-paying hospital with 250 beds was opened and another free hospital with 350 beds followed in 1984; by the turn of the century there were around 1500 beds (of which the majority were free) in Madurai. The model spread out to other locations across Tamil Nadu so that **by 2003 there were five Aravind hospitals with a total of 3649 beds of which 2850 were free**. [492] [494]

At Aravind, there are typically two patients in the operating theatre at the same time. One would be undergoing surgery, while the other was being prepared. The microscopes used during the operation can swivel between the separate operating tables to further save time. In this way, surgeons are able to perform nearly **100 operations in a 12-hour** working day, around 10 times the norm in the rest of India. **In the financial year 2009-10, they performed 302,180 operations, of which more than half were free of charge**. [473] [494]

3.1.1.6. Model Improvement

Just as Ford, McDonalds and Toyota focused on continuously improving and extending their system models, so the Aravind Eye Hospitals gradually shifted to become the Aravind Eye Care System. Key elements were added – for example, a dedicated factory for producing lenses, a training centre to provide key skills, specialist ophthalmic research centres, and an international eye bank. [492] [494]

3.1.1.7. Very Low Cost

Exploiting new income streams helps cut costs for the core business. Aravind Eye Care was concerned about the high price of available intraocular lenses and subsequently undertook research to develop a manufacturing process that resulted in cutting the cost of lenses significantly. Today, it's manufacturing facility, Aurolab, exports lenses and other **supplies to more than 120 countries**. [473]

Central to the success of the model have been the economics. Target costing is a well-known tool in product innovation for engineering the design of production systems, and in the case of the original cataract operation Dr. V. set this as being around $50/operation (assuming no complications ensued). This compares to around **$300 as an average cost for treatment in a conventional Indian hospital (and $1650 in a US hospital).** Developing and refining the system has meant that the **average cost in the Aravind system is $25**, based on a proportion of patients paying between $50 and $300 but over 60% being treated free. In 2003 Aravind became the largest single cataract surgery provider in the world. The key is in the volumes – around 200,000 patients are treated each year, based on the high volume/low margin kind of business model which Henry Ford used on the Model T and which now drives the low cost airline industry. [492]

Inevitably the approach involved rethinking the underlying model. In a conventional Western hospital an eye operation would **typically take 30 minutes** – yet the **Aravind system needs only 10**. This high productivity is achieved by **significant process innovation** driven by close analysis of value adding time. For example, each surgeon works on two operating tables alternately, and is supported by a team of paramedics to carry out less-skill dependent aspects such as washing the eye, putting in sutures, giving anesthetic injections etc. 70% of activities are carried out by a team of 4 nurses supporting the surgeon, 2 assisting directly and 2 acting as 'running nurses' bringing fresh instruments from the sterile area. [492] [494]

3.1.1.8. High Quality than UK

Of considerable importance is the fact that this treatment is not provided at low cost by compromising on quality. A key statistic in medical care is infection rate – and the Aravind system actually has better performance than many Western hospitals. For instance in 2004 it was **about 4 per 10,000 cases** at Aravind, while the UK published rate was **6 per 10,000**. [492]

But there is another important feature to this story. With such a high volume of surgery – 200,000 plus cases per year, with each doctor carrying out around 2600 operations/year (against an Indian average of around 400) – comes a rich learning opportunity. [492] [494]

3.1.2. Narayana Hrudayalaya: World's Largest Pediatric Cardiac Hospitals

The Wall Street Journal article stated that "Dr. Devi Shetty in the Henry Ford of Heart Surgery". [498]

Dr. Devi Shetty, was motivated by the empathy of Mother Teresa whilst employed as her personal cardiac surgeon. He established an innovative business model creating Narayana Hrudyalaya that has now become one of the **world's largest pediatric cardiac hospitals**. [473]

Narayana Hrudayalaya, a pioneer in low-cost cardiac care, is building a chain of hospitals that will carry out heart surgeries at the cheapest rates in the world, buttressing **India's reputation as the Mecca for frugal innovation**. A series of design and operational advancements, ranging from construction techniques to post-operative care, will mean that an open heart surgery can be performed for as low as Rs 65,000, or about one-fourth the cost in a corporate hospital. The 200-bed, 1.5-lakh-square-foot Narayana Hrudayalaya hospital, set up with an investment of about Rs 45 crore - 80% cheaper than similar multi-specialty facilities - is built on a nine-acre plot. [495]

Narayana Hrudayalaya that provides affordable cardiac surgery is a good example. It performed **3,174 cardiac bypass operations in 2008**, more than **double the 1,367 at the Cleveland Clinic** that is seen as a **leader in its field in the US**. Narayana reports a **1.4% mortality rate** within 30 days of bypass surgery compared to a rate of 1.9% in the US22. The cost of open heart surgery at Narayana, however, is only **£1250 compared** to **£12,500-£85,000 in US hospitals** and around **£3000 in private hospitals in India**. Narayana is now offering the UK NHS cut-price operations for British citizens at 1/12th of the cost that they are available in Britain. [473]

NH has been able to bring down the cost of heart surgery to the equivalent of USD 1,400 to 1,500. But their target is to bring this **down to $800.** This is thanks to scale – NH already does **30 heart**

surgeries per day and performs the largest number of kids' heart surgeries in the world with children from **70+ countries** being treated at NH. [496]

Fig. 3.3: Dr. Devi Shetty [496]

Dr. Devi Prasad Shetty, cardiac surgeon and founder of Narayana Hrudayalaya said that "Charity is not sustainable, there has to be a business model. Innovations have to be affordable; a magic pill will not do." [495]

3.1.2.1. Huge Volume

In 2001, he founded Narayana Hrudayalaya (later renamed Narayana Health or NH) in Bangalore with a mission to take affordable health care to the people. What started as a 280-bed hospital then has, in the last 13 years grown to become a 26-hospital network with 6,900 beds across 16 cities employing 13,000 people and 1,500 doctors. It has so far performed over 100,000 cardiac surgeries and 250,000 cath lab procedures. The group performs 150 major surgeries (including 44 cardiac surgeries) daily. NH says about 12 per cent of all cardiac surgeries done in the country are performed at its hospitals and 50 per cent of its patients are from the economically-weaker sections. [497]

3.1.2.2. Hugh Salary Saving

According to Dr. Devi Shetty, the key difference between the hospitals that Narayana runs and those in the developed economies of the West revolves around staff costs. While hospitals in the West spend 60% of their revenue on salaries (including surgeons' fees), Narayana has to restrict this to around 20%. This does not mean that doctors at Narayana are poorly paid. However, they do work longer hours and are required to be more productive. [473]

Cardiac surgeons at Dr. Shetty's hospitals are paid the going rate in India, between $110,000 and $240,000 annually, depending on experience, says Viren Shetty, a director of the hospital group and one of Dr. Shetty's sons. [498]

3.1.2.3. Staff Support

Narayana goes a step further by guaranteeing bank loans taken out by trainee nurses to cover their fees and living expenses in return for a commitment to work at the hospital during their course and for two years thereafter. [473]

3.1.2.4. Reduced Capital Expenditure

The hospital buildings are designed to keep costs low. Cost of Narayana Health's Mysore hospital was Rs 18 lakh per bed against the thumb rule cost of Rs 50 lakh a bed. Narayana Health does not buy all the equipments. Some it leases and pays on per-use basis. A good example is use of cold sea water (instead of a refrigeration process) to provide air-conditioning. Narayana Health tries to adopt technology to smoothen information flow and hence decision-making. [575]

Narayana Hrudayalaya also reduced capital expenditure by buying low-cost medical equipment from small Indian firms and having a pay-per-use model for the more expensive ones. Also, the electricity bill is expected to be much lower due to the absence of elevators and air-conditioning as well as better use of natural light. In addition, unlike in other Indian hospitals, they are paid a fixed salary instead of a percentage of the revenue that they generate. [473]

NH has also been open to experimenting. When it set up a 104-bed hospital at Cayman Islands in the Caribbean, it chose to use the cold water available from the sea to replace the energy intensive refrigeration system. Energy savings, as a result, were as high as 90 per cent. This is significant considering that power cost in the islands was three times that of the US. NH's decision to set up oxygen plant there rather than source them will soon be implemented in its other hospitals as the plant pays back in just six months. [497]

3.1.2.5. Economies of Scale

Narayana conducts around 500 blood tests a day, while other hospitals may conduct only two or three. This enabled them to obtain the equipment free of charge from their supplier, as the consumption of reagents was high enough to make the transaction profitable for the supplier. [495]

The multi-specialty hospital chain in India builds large facilities and leverages economies of scale. The hospital chain innovates constantly and this helps to lower costs. [575]

The hospital has set up a central buying unit (CBU) and standardized purchase of consumables and devices. Close to 80 per cent of all purchases are through the CBU. This has cut inventory costs by 15 to 40 per cent and ensured quality. [497]

3.1.2.6. Innovative Business Model: Long-Term Value for Investors

The focus on both cost and quality has not hurt NH's financials either. While NH's revenues grew by over 200 per cent in the last five years to Rs 827.35 crore in 2012/13, its earnings before interest, taxes, depreciation, and amortization (EBITDA) margin is a healthy 13 per cent. (NH's EBITDA for 2012/13 stood at Rs 97.79 crore.) Private equity funds JPMorgan and Pine Bridge have picked up a 24 per cent stake in NH. They clearly believe NH is creating long-term value for investors. [497]

Next door to Narayana, Dr. Shetty built a 1,400-bed cancer hospital and a 300-bed eye hospital, which share the same laboratories and blood bank as the heart institute. His family-owned business group, Narayana Hrudayalaya Private Ltd., reports a 7.7% profit after taxes, or slightly above the 6.9% average for a U.S. hospital, according to American Hospital Association data. [498]

3.1.2.7. IT and Business Intelligence Model

NH also adopted technology to aid information flow. Here too the frugal mindset came into play. It deployed its enterprise resource planning (ERP) on the cloud rather than setting up data centres. This not only cut initial costs but was easily scalable. The IT system helps NH in many ways. An SMS is sent at noon daily to senior doctors and administrators informing them of the previous day's revenue, expenses and EBITDA details. This enables the management to decide quickly when requests for free or subsidized surgery come. [497]

NH also mines data to raise quality levels. Its business intelligence model throws up real time data on 30 different parameters that the management may want to track for improving efficiency. Those related to clinical outcomes are then discussed at the weekly Mortality Morbidity Meeting held every Thursday where all major clinical procedures are discussed among doctors and best practices shared. "Through business intelligence, we are trying to map the performance of each doctor in terms of clinical outcome and financial data such as consumable used during surgery, time patient has spent in ICU and duration of stay in the hospital," says Dr Raghuvanshi. [497]

3.1.3. IndiGo - Youngest & Fastest Growing Low-Cost Carrier in the World

The IndiGo airline revolutionized the low-cost carrier industry in 2000. By adopting an efficiency-centred business model, it established itself as the leader in the Indian low-cost carrier fraternity, providing excellent customer service, fast check-in and low prices. [556]

3.1.3.1. Vision

Aditya Ghosh, President, Indigo Airlines stated that "**USA** is a country which is **1/3rd in size to India in terms of population** but it has around **13000 commercial planes**. India is therefore one of the under- penetrated aircraft market in the world. **Less than 1% of rail traffic in India flies by Air**, that means **if we can convert 1% of rail traffic into air, we will need double the size of airlines** in business that exists in India today. That is the opportunity we are chasing at Indigo." [558]

Fig. 3.4: IndiGo Airlines [557]

3.1.3.2. Fastest Growing Low-Cost Carrier in the World

Since its launch in 2006, IndiGo has been the **fastest growing low-cost carrier in the world**, while posting profits over the last three years. In the 12 months ending March 2011, the airline achieved a 25 percent profit margin on its operations, generating a profit of USD132 million. Traffic in the 2010-11 fiscal year grew with 39 percent, with average load factors above 80 percent. [560]

3.1.3.3. Awards and Recognitions

- 2012 Innovation for India Awards
- Marico Innovation Foundation award
- Skytrax Awards – Best low cost carrier (2010, 11, 12, 13, 14): For five years in a row, IndiGo has been named as one of the top 50 companies to work for in India and the best in the transportation industry.
- Best LCC (low-cost carrier) by the Airline Passengers Association of India (2007).
- Best LCC at the Galileo Express Travel Awards (2008)
- CNBC Awaaz's Travel Award for best low cost airline (2009, 2013)
- The Airline of The Year (India) at GMR Group Indira Gandhi International Airport Award.

3.1.3.4. Net Income Has Grown More Than Five Times

Its market share is 32.6% as of May 2014. [559] [561]

Since 2008, when the company booked its first profit even as high fuel prices and the economic downturn ravaged its competitors, IndiGo's net income has **grown more than five times** — from a shade under **$20 million to more than $120 million**. With Boeing forecasting that Indian air traffic will grow 15 percent a year over the next five years and that India will require more than

1,000 commercial jets over the next 20, according to the Wall Street Journal, that may just well make IndiGo the fastest growing airline in the world's fastest growing aviation market. [557]

3.1.3.5. Bulk Purchase and Fuel Efficient Planes: Key to Innovation

The key innovation was simple. Like Tata Motors did with the Nano, Indigo leveraged India's huge potential market to form a cost-cutting partnership with suppliers — Airbus, in this case — thus reducing its cost of operations before it sold its first ticket. In 2005, when other low-cost carriers were working with older, leased aircraft and battling a reputation for inferior service, Indigo inked a deal to buy **100 new A-320 jets** from Airbus, purchasing at volume to ensure a lower price and a partnership-type commitment on maintenance. "The first order of 100 aircraft [from Airbus in 2005] was game-changing. They got a wonderful order, and a good price that gave them the leverage that a startup carrier requires," said Kaul, citing the superior maintenance support that the purchase gained them from engine and airframe manufacturers. "That [big one-time buy] ensured they became part of the manufacturers' business model." [557]

The savvy purchase helped IndiGo rocket up the ladder to the No. 2 position in India by market share (18.6 percent) this January, after only five years of operations. And the company has already signed another huge deal — a record-setting, **$15.6 billion purchase of 180 more passenger jets** from Airbus — that promises to allow it to leverage those same strengths when it starts international service this summer with flights to Singapore, Bangkok, Dubai and Muscat. [557]

IndiGo has taken delivery of its first A320 aircraft equipped with **Sharklet fuel saving wing tip devices**, becoming the first Indian carrier to do so. Sharklets are newly designed wing-tip devices that improve the aircraft's aerodynamics and significantly cut the airline's fuel burn and emissions by four per cent on longer sectors. This milestone makes us the first airline globally to introduce on A320 aircraft powered by IAE engines. Sharklets are an option on new-build A320 family aircraft, and standard on all members of the A320 neo family. They offer the flexibility to A320 family operators of either adding around 100 nautical miles more range or allowing increased payload capability of up to 450 kilograms. All future A320 aircraft to be delivered to IndiGo shall be fitted with the Sharklet wing tip devices. [559]

3.1.3.6. Unique Challenge

We have a unique challenge in our business: Less than 10% of our employees sit in one office, even If I have to do a webcast 50% of my colleagues are either flying on a plane or doing something more important than listening to me. So, I have to find a way to reach out. We have even more unique challenge. One of our customer said I love the way the check-in staff comes up and talks to me and that's a unique challenge. In many businesses when you have the most important customer walk in through the door, you have the CEO receiving him. For me when the most important customer travels in Indigo, the senior most people at Indigo that that person ever meet is a check-in agent, a ramp staff or a flight attendant. So how do we ensure or how do we create a culture where each one of those people feels empowered. In the word empowerment is the power and for me power is the power to make a change, the power to make a change in their life and the power to make a change in the customer's life. And that's what makes them to think differently. [558]

3.1.3.7. Innovative Facilities and Performance

Indigo turned regular business travelers into loyal customers because it never acted like a budget airline. From the beginning, its purchase of all new aircraft helped it avoid maintenance problems, and superior planning helped it to match or exceed the on-time performance record of its full-service competitors — even though rapid turnaround of its planes was the key to the company making money. [557]

IndiGo pushed best practices even when there was no compelling reason to do so. In a country where other carriers shared passenger-stair vehicles and the top airline still had to have disabled passengers carried up the staircase to plane height by ground crew, for instance, Indigo brought in larger, handicapped accessible passenger ramps from day one. [557]

In a country with limited Internet access, IndiGo chose to go ticketless from day one, offering customers web and mobile check-in facilities. Similarly, the company equipped check-in staff with hand-held scanners that allowed passengers without baggage to avoid the dreaded scrum at the counter. And at least in the beginning, flight attendants manning the beverage carts addressed even lowly economy class passengers by name (with the aid of the seating chart). Staff with so-called 'Q-Busters' – hand-held devices that print out boarding passes to minimize queues – offer passengers the capability to check in anywhere at the airport. IndiGo also provides extra seat pitch (2 inches more than India's industry standard). Wieden + Kennedy has also worked with IndiGo to develop inflight menus, safety cards, sickness bags, and other in-flight packaging designed to entertain passengers with a mix of functionality and fun. For example, IndiGo's triangular paid-for 'Airwich' boxes, in the airline's words, "double as a sandwich box and a new medium to feature interesting stories and cool illustrations that make meals enjoyable beyond a few bites." [557] [560]

Aditya Ghosh, President, Indigo Airlines stated that "We have created our own products which are aimed at enhancing customer convenience and experience. IndiGo offers **web- check in**, **Q-busters** and **self-check-in kiosks** for an easy and faster check-in. In addition, we also offer fast **forward check-in facilities** at a price that provides enhanced convenience. We will continue to offer such services and continuously innovate to further improve the experience." [559]

The airline introduced a new initiative called '**Braille guide**'. This is one-of-its-own kind in Indian skies and this guide has illustrations designed for keeping in mind the visual, sound and speech impaired passengers, who find it difficult to communicate. This guide helps such passengers to communicate with the crew on-board in case they require anything. The guide has illustrations of different objects designed that may be required by the passenger in the flight. Importantly, the guide at the same time has the Braille letters engraved corresponding to their English texts signifying the illustrations designed. [559]

The airline says it has an aircraft **utilization time of 11.5 hours per plane every day** for its fleet of 50 aircraft, significantly **higher than the industry average**. The **turnaround** for each aircraft averages about **30 minutes**, much swifter than other carriers. According to IndiGo's president Aditya Ghosh, the airline's "**technical dispatch reliability is 99.91%**" and flights "almost **always reach destinations 15 minutes earlier than scheduled**. Our record for impeccable punctuality has been responsible for success with corporations." [560]

3.1.4. UFO Moviez: Revived the Loss-Making Business of Film Exhibition

3.1.4.1. Revived the Loss-Making Business of Film Exhibition

For pioneering the digital movie distribution industry in India. UFO **revived the loss-making business of film exhibition by offering MPEG-4 compression and digital streaming, making it a cheaper for cash-strapped theatre owners**. It's now banking on its IMPACT ticketing platform, which promises to provide real-time and accurate reporting of ticket sales, bringing much-needed transparency to the movie distribution business. [563]

Mr. Sanjay Gaikwad, Managing Director, UFO Moviez, said, "We are honored to receive the award for Innovation from the Marico Innovation Foundation. Such recognition encourages us to continue to pursue our mission of combining technology innovation with operational excellence, offering end to end digital cinema solutions to the industry. Our strength lies in our **innovative business solutions** that are **cost effective** and offer **zero compromise in quality**, **reliability** and **security** at the same time." [565]

3.1.4.2. UFO Moviez: World's Largest Satellite Delivered Digital Cinema Network

UFO Moviez, the world's largest satellite delivered digital cinema network, has revolutionized the way films are distributed and exhibited throughout India. Presently, UFO has a base of 2,880 digital screens (including 152 3D Screens), spread in 1,300 cities in 28 states of India. Out of these, around 350 screens are in multiplexes (which constitutes over 30% of the multiplex population in the country) and the balance are single screen theatres. UFO has so far released 4,265 films in 30 languages and has conducted over 9.7 million shows till date. [565]

Fig. 3.5: UFO Moviez [564]

3.1.4.3. Awards and Recognitions

- **Innovation** for India Awards 2012
- IIFA Award: For the 'Biggest **Innovation** in the Film Industry' at the 8th International Indian Film Academy Awards held at Yorkshire, England, in June 2007.
- Maharashtra Corporate Excellence Awards (Maxell) 2014
- Inc. India's Top 500 fastest-growing companies
- Deloitte fastest growing 50 companies in TMT space
- Global Entrepolis @ Singapore Award [570]

3.1.4.4. Before Digitization: Major Problems and Question of Survival of Film Industry

Sanjay Gaikwad, Founder and CEO, UFO Moviez, used to read about Hollywood films earning hundreds of millions of dollars at opening weekends. Hollywood would release films in 8,000 to 10,000 theatres simultaneously, while the biggest Bollywood film would not go in more than 500 theatres before 2005. This was killing the industry, as these 500 prints were also being released in the second round in tier II and tier III theatres in a staggered manner, opening up a window of opportunity for pirates. It was this realization that triggered the UFO concept in Gaikwad's mind. [564]

First, a little bit about the Indian film industry. In terms of content volume, the Indian film industry is the largest in the world, producing more than 1,300 films annually. In 2011, an estimated 3.3 billion movie tickets were sold in India. This is the highest number of tickets sold in the world, and yet India is a highly under-screened country with a screen density of 12 per million people as compared to 117 per million in the United States. Also, **before digitization, the Indian film industry was plagued by piracy, lack of transparency, leakage of revenue, and opportunity loss in terms of exploitation of the theatrical rights of films**. So what was the problem? The end product of the film industry, the full-length feature film, has always been a highly perishable commodity as far as theatrical collections are concerned. With the exception of about 10% 'hit' films, the rest of the movies have had an average lifespan of 6–14 days in any given theatre. Hence, it is essential that theatrical collections are maximized in this short span of time, which is only possible if the film is simultaneously released in an optimum number of theatres. Till 2005, for exhibiting a film in a theatre, the producer/ distributor had to provide a print (reel) of the movie, which used to be very expensive at approximately R50,000–60,000 per print. Hence, the producer/distributor, depending on budgets, would take out a specific number of prints to send to theatres and would maximize revenues by ensuring that such prints were sent to the most profitable centres in the metros first. After screening in the top theatres in the metros, the reel would then be passed on to theatres in tier II and tier III cities/towns. **By this time, the print would have suffered loss of quality and the film would have fallen victim to piracy**. Also**, audiences in these cities needed to wait for weeks for the prints to trickle into the local theatres**. As a result, **theatres suffered loss of business**. In addition, the exhibition and distribution sectors were highly disorganized, and there was a need to consolidate the market and increase the distribution spread to efficiently maximize the revenues. [564]

3.1.4.5. Innovative and Challenging Task

UFO Moviez envisioned the seamless distribution of films via satellite from day one, creating a technology-driven platform where all existing players in the value chain come together, do business, and are profitable. This was a difficult task to accomplish, especially since this particular deployment of technology—delivering films via satellite to theatres—was a global first. Right from earning the trust of the film industry, to sourcing content, to convincing cinema halls across the length and breadth of the country to use this brand-new technology, Team UFO had to surmount many challenges. We realized that the only way to overcome the reliance on expensive print and guarantee a widespread 'first day, first show' release in a country as vast as India was through satellite delivery of digital cinema. UFO's use of MPEG4 technology allows content to be sent to theatres via satellite, and today UFO is the largest satellite-based digital cinema network in the world. UFO's success lies largely in its introduction of unique business offerings to the industry such as the 'pay per show' business model, which helps maximize profits for both distributors and exhibitors. UFO's operations are structured to be a platform provider, to provide an end-to-end gamut of services to the film industry right from sourcing content to digitizing it, providing and maintaining equipment in cinemas, delivering content to theatres, enabling the play out of content in the cinemas, and providing feedback to distributors. The distributor is insulated from any breakdown, technology obsoleteness, failures, etc. UFO Moviez is essentially a single point of contact for a film to release in more than 3,000 screens across India. [564]

3.1.4.6. The impact

UFO's innovative solutions have helped the industry to conduct business in a more efficient way. Theatres and distributors now reach out to each other digitally for the purpose of delivery and playback of films.

- If one were to go back only six years in time, one would find that the then blockbuster films managed to reach barely about 500 theatres, with low-budget films finding it tough to secure a release in even 100-plus theatres across India. Today, a blockbuster release can easily reach 3,000 theatres across India, providing a win-win solution to the entire ecosystem.
- Producers and distributors are assured of a wide release in a transparent fashion, exhibitors (theatre owners) are enjoying a revival in business, and audiences across the country are able to enjoy first day, first show screenings wherever they are.
- In smaller towns and villages, where most audiences were able to view a new film as late as two months after its all-India release, cinema enthusiasts can now see all new releases first day, first show.
- Territory distribution prices have as much as tripled in certain regions vis-à-vis pre-UFO days. Also, regional language cinema, which was badly affected by the lack of outreach to audiences and spiraling print costs, is now revived.
- Even defense personnel in remote areas such as Leh are able to watch films first day, first show, thanks to UFO's digital cinema solutions. Small-budget, niche cinema has also benefited immensely. [564]

3.1.4.7. Innovative Practices

UFO Security Solutions (Watermarking)

UFO follows the concept of Invisible Watermarking. Each theatre-server displays a unique fingerprint (both visible and invisible) when projecting the digital movie on the screen in a non-intrusive manner. Using this technology security feature, it is possible to trace, from a pirated CD or DVD, the name and location of the theatre where the film was illegally video-graphed, along with other co-ordinates like time, date, etc., thus helping to crack down on Piracy. [570]

UFO Ticketing Platform (IMPACT)

UFO launched a settlement platform called 'IMPACT' to bring transparency, efficiency and accountability in the Media and Entertainment business.[12] IMPACT exchange operates in real time and is connected to the back-end via satellite. IMPACT exchange mediates the transaction between the exhibition centers on one hand, and the government and the distributors on the other hand. In consideration, a commission fee is to be paid by the distributors, government and a small equipment fee from the exhibitors. IMPACT supports multi-terminal, multi-user transactions with a user-friendly interface. It has a faster printing facility for tickets to reduce transaction time and customized screen configuration of ticket sales for operational ease. [570]

Innovative 3D solutions

UFO has indigenously developed a very cost effective technology to convert existing 2D screens into 3D. At the theatres where this technology is implemented, there is a dual projection setup for 3D projection along with a playback server, 3D format converter, polarized filters, silver screen and 3D glasses. Video output from the server is connected to a 3D format converter. [570]

IPL Live Matches

UFO brought cricket matches of the Indian Premier League (IPL) live to over 700 cinema screens in high definition in 2010. The last four matches of the Indian Premier League (IPL) 2010 were brought live in theatres in 3D. [570]

3.1.4.8. GDP Point of View Importance of Film Industry: Hollywood and Bollywood

The Indian film industry is expected to grow to 138 billion Rupees by 2014 – that's **$2.28 billion**. The numbers are certainly impressive - in terms of the number of films produced each year, Bollywood is firmly on top of the pile with 1,602 in 2012 alone. The U.S. churned out 476 films that year while the Chinese managed 745. In the same year, **Hollywood sold 1.36 billion tickets** compared to Bollywood's whopping **2.6 billion**. Indian films can't match Hollywood in box office revenue, however. U.S. films grossed nearly **$10.8 billion in 2012** compared to India's meager **$1.6 billion**. [566]

The entertainment industry is in good health, contributing Rupees 50,0000 crore to the economy, equating to **0.5% of GDP in 2013**, according to the report 'Economic Contribution of the Indian Motion Picture and Television Industry', by financial services firm Deloitte. [569]

Creative industries led by **Hollywood account for about $504 billion**, or at least **3.2 percent of US GDP**, the government said in its first official measure of how the arts and culture affect the economy. [567] [568]

The total output from arts and cultural production, another measure of economic activity, was $916 billion in 2011, analysts found. That includes $200 billion from creative development in advertising, $104 billion from arts education including college art departments, $100 billion from cable TV and $83 billion from movies and video services. [568]

3.1.5. GVK EMRI: World's Largest Integrated Emergency Service Provider (Free)

The GVK EMRI respond to **30 million emergencies and save 1 million lives annually**. They are **Serving 1 Emergency every 8 seconds and Saving 1 Life every 8 minutes**. They Provide Emergency Response Services under PPP (Public Private Partnership) framework. They deliver services at Global standards through Leadership, **Innovation**, Technology and Research & Training. [571] [573]

Subodh Satyawadi, CEO, GVK EMRI said that "According to Disaster Management in India (2011), a report by the Ministry of Home Affairs, Government of India, the country is one of the ten worst disaster-prone countries of the world. Out of 28 states and 7 union territories, 27 are prone to moderate to extreme natural disasters. Apart from our volatile topography, manmade disasters only add to our woes. The rate of accidental deaths grew by 32% in the last decade, and in 2010, accidental deaths saw an increase of 50% as compared to 2000, according to Accidental Deaths and Suicides in India (2010), a report by National Crime Records Bureau, Ministry of Home Affairs. An efficient emergency service is thus a crying need." [574]

Fig. 3.6: GVK EMRI [573]

Why this Innovation ?

- 75,000 emergencies occur per day
  - 80% are at the bottom of the pyramid
  - 80% deaths occur in hospitals in the first hour
- 4 M deaths p.a. (Cardiac, Road Accidents, Maternal, Suicidal attempts, Neonatal / Infant / Pediatric, Diabetic related, etc) due to absence of 4As :
  - **A**ccess to a universal toll-free number
  - **A**vailability of Life Saving Ambulance to reach quickly nearest and appropriate health facility
  - **A**ffectionate Care by trained paramedics (Compassion, Ability, Resourcefulness & Energy)
  - **A**ffordability by every citizen independent of income, religion and community

•Hence, GVK EMRI was born in April 2005

What is Unique in this Innovation ?

CALL 108 EMERGENCY •MEDICAL •POLICE •FIRE

- Integrated Emergency Response Services for Medical, Police and Fire emergencies with single universal toll-free number '108'
- Free services (no cost to citizen)
- PPP framework
- Government provides funds for OPEX & CAPEX
- Private Partner brings leadership, innovation, execution and technological capabilities
- Conducting Research and building capability in Emergency Medicine and Management

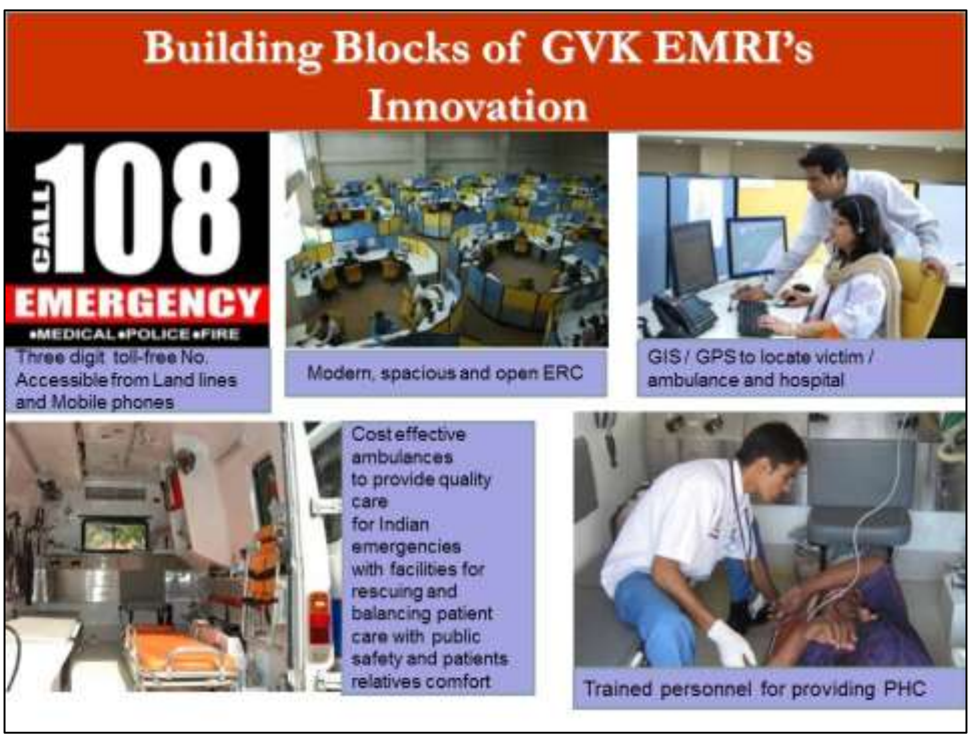
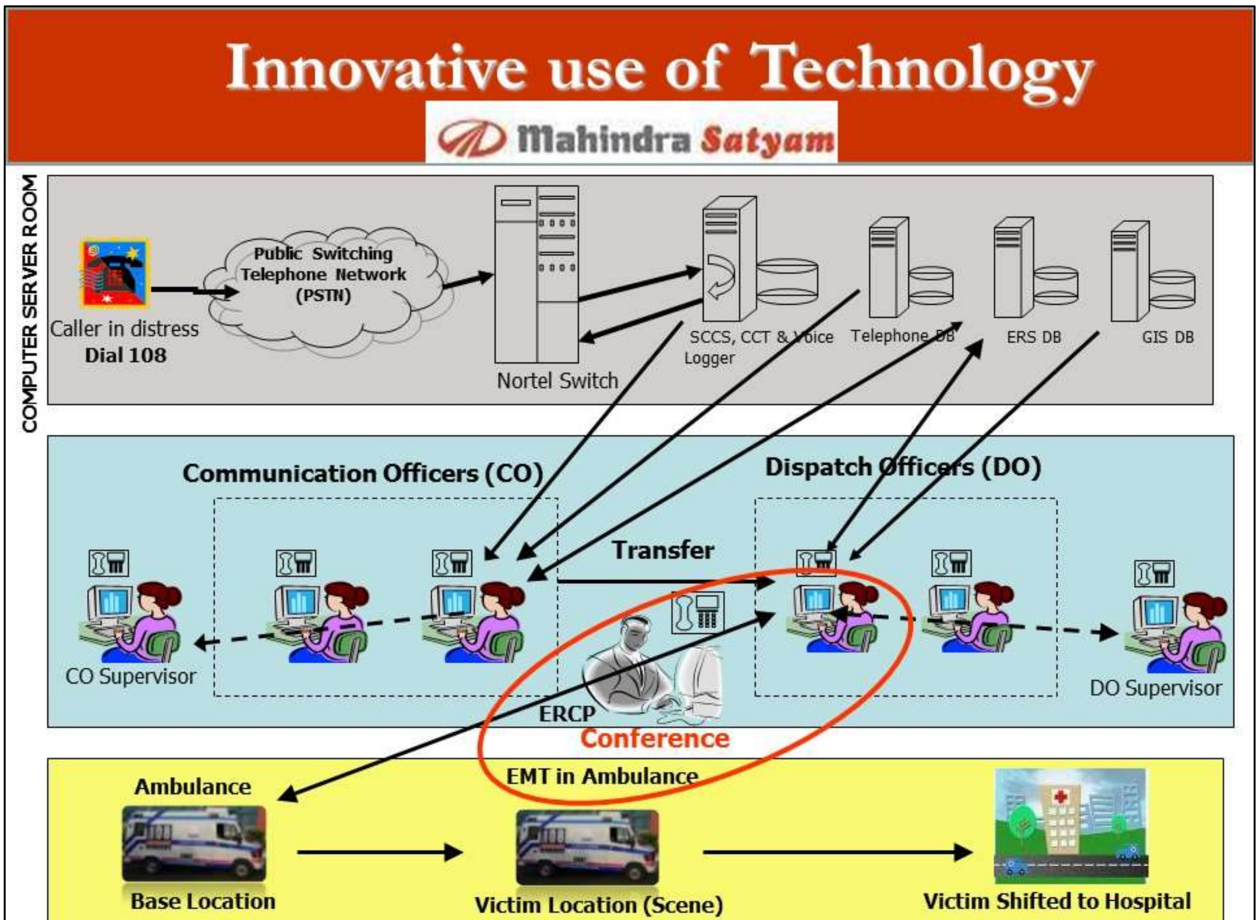


Fig. 3.7: GVK EMRI Innovation: Excellent Presentation by Dr. G V Ramana Rao, Executive Partner Medicine Learning Centre and Research, GVK EMRI [573]

3.1.5.1. Hi-tech Services

The Organization has created a distinctive Technology Infrastructure that is readily deployable and scalable. Automation of the processes involves the following major components of technology:

- Telecom Switch with automatic call distribution features & IVR facility
- Computer Telephony Integration
- Voice Loggers
- GIS/GPRS Software
- AVLT – Automatic Vehicle Location and Tracking
- Mobile Application
- Allows tracking of call based on location of caller
- Enables Dispatch Officer to access the GIS Vector data (maps) provided by Government agencies and identify the incident location
- Identifying the exact location of ambulance on real time basis [571]



CCT: Communication Control Toolkit; SCCS: Symposium Call Centre Server; ERCP: Emergency Response Center Physician; EMT: Emergency Medical Technician

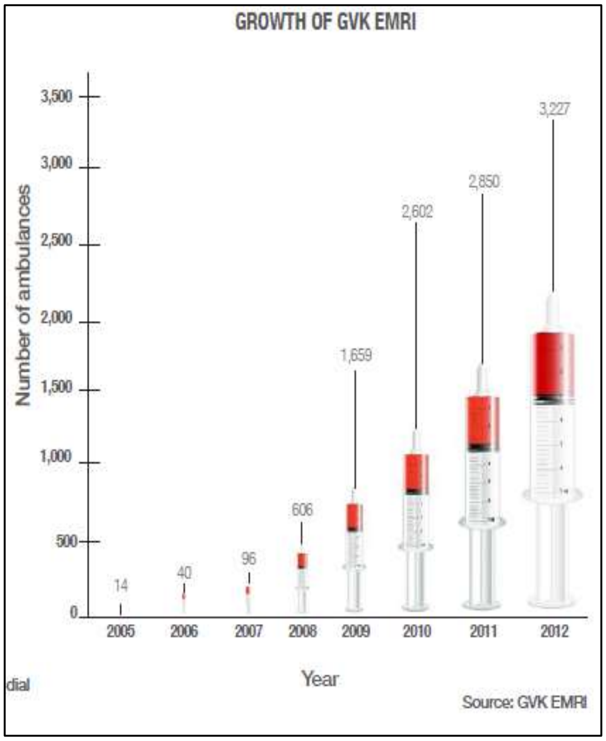
• After substantial R&D, a GPS-based electronic pre-hospital care record (ePCR) system that is integrated with an automatic vehicle location tracking system (AVLTS) has been developed. This equipment can be used for various non-medical and medical purposes. Its applications include locating a vehicle on geography information system (GIS) maps, navigating with the help of GPS, bio-attendance of EMS staff, two-way video conferencing between the paramedic and the doctor, transmitting the patient's/victim's baseline vital parameter measurements and ECG recordings to the doctor, etc. With the help of this device, we also keep a record of hospitals, police stations, fire stations, disaster management centres, etc., and prepare geo maps that can be used to respond to possible massive-scale disasters. Another part of the above device is a handheld touch pad, which is used to electronically transmit the ePCR and details about the patient/victim to the doctor/centre.

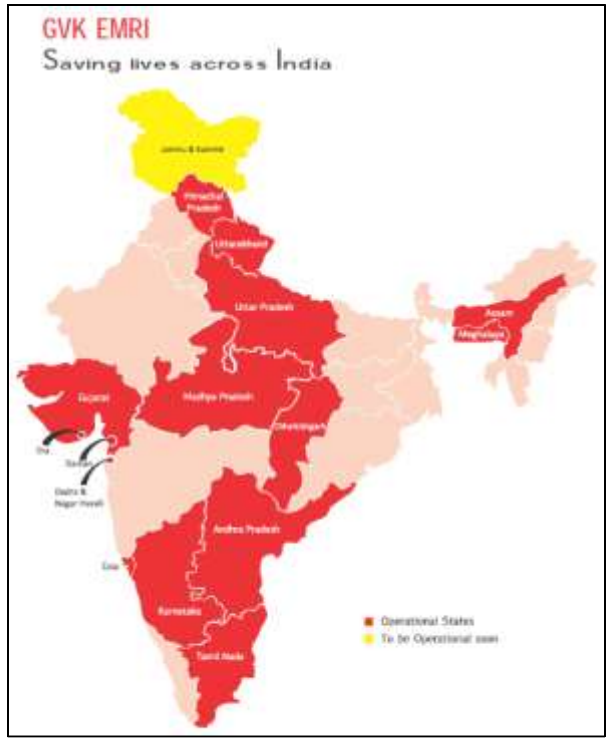
Fig. 3.8: GVK EMRI: Innovative use of Technology [573] [574]

Fig. 3.9: Ambulance Medical Equipments: Suction Apparatus, Automated External Defibrillator [573]

Fig. 3.10: GVK EMRI Ambulance Facilities [572]

3.1.5.2. Growth of GVK EMRI





S No	Name of the State Government	Date of Launch	Ambulances	Emergencies Attended Since Inception	Lives Saved	Deliveries Assisted	Pregnancies Handled	RTA's Handled	Associates
1	Andhra Pradesh	15th Aug'2005	802	7,368,296	108,574	87,165	1,461,415	1,005,101	3,803
2	Gujarat	29th Aug'2007	525	3,543,146	248,171	35,993	1,212,549	556,473	2,778
3	Uttarakhand	15th May'2008	140	538,688	10,926	4,478	188,235	60,086	734
4	Goa	5th Sep'2008	33	192,954	13,248	346	13,209	38,678	188
5	Tamilnadu	15th Sep'2008	620	2,274,276	76,183	11,794	528,533	505,429	2,939
6	Karnataka	1st Nov'2008	517	2,409,587	72,419	27,795	941,545	230,029	2,715
7	Assam	6th Nov'2008	285	1,313,672	59,620	11,712	492,853	83,832	1,522
8	Meghalaya	2nd Feb'2009	46	66,323	7,372	628	17,959	7,108	239
9	Madhya Pradesh	16th Jul'2009	274	525,859	29,591	4,689	198,395	84,102	1,689
10	Himachal Pradesh	25th Dec'2010	112	251,950	4,479	1,930	48,050	13,969	622
11	Chhattisgarh	25th Jan'2011	240	375,600	15,365	7,570	154,682	39,795	1,336
12	Uttar Pradesh	14th Sep'2012	988	392,118	-	5,670	191,585	48,838	4,923
13	Diu Daman & Dadra Nagar Haveli	10th Apr'2013	13	13,552	732	73	3,305	2,199	78
National			4,595	19,266,021	646,680	199,843	5,452,315	2,675,639	23,566

Fig. 3.11: Growth GVK EMRI [562] [571] [572]

3.1.5.3. Award and Recognitions

- The NASSCOM Social **Innovation** Honors 2012 Award
- Piramal Prize for **Innovations** in the Established Organization Category
- **Innovation** for India Awards 2012 in Public Service category
- E-India Best Ngo Initiative: This award recognizes and appreciates the hard work and achievements of NGO are who have transformed social development opportunities into sustainable social enterprise through **innovative use of ICT's**.
- Global CSR Excellence & Leadership Award in Best use of CSR Practices in Health Care
- The Project Management Institute, Pearl City Chapter confers Special Recognition Award
- 7th e-India Award for enabling IT in Saving Lives
- Corporate Executive Citizen Karma Veer Puraskaar 2010 Award
- NASSCOM CNBC TV18 IT User Award
- Eastern Panorama Award
- E North East Award 2013 in E- Health category

3.1.5.4. How GVK EMRI Operates

Fig. 3.12: GVK EMRI: Sense, Reach, Care and Follow-up system [572]

3.1.5.5. Emergency Medicine Learning Centre (EMLC)

Dr. Ramana Rao, GV leads the Emergency Medicine Learning Centre (EMLC) team, and Research divisions at GVK EMRI. He is Coordinator of ITO, American Heart Association, USA and Medical Director for ITLS (international Trauma Life Support) Chapter at GVK EMRI. He represents GVK EMRI in disaster management issues at the State and National levels. The faculty of EMLC team is composed of distinguished and experienced professionals from various walks of Health Care. With many years of industry experience, and considered to be the best among the peers, they act as facilitators in the participant's learning process. Faculty members at GVK EMRI generate knowledge through cutting edge research in all functional areas of Emergency management that would benefit delivery of public and private health care Emergency systems in the society. Many text books and working papers are written on a regular basis and articles are published regularly in reputed journals which itself is an indication for the desire to excel in Academics. EMLC team is actively involved in external training as well.

The external training centers include:

- Affiliations in Training: Stanford University, USA
- Carnegie Mellon University, USA
- Geomed Research
- Singapore Health Services
- American Academy for Emergency Medicine
- American Association of Physicians of Indian Origin (AAPI)
- Shock Trauma Centre, USA
- American Academy of Family Physicians (AAFP)
- International Trauma Life Support & American College of Emergency Physicians
- Osmania University, Hyderabad
- Public Health Foundation of India

Fig. 3.13: Collaboration for transfer of Knowledge and Technology know-how, Best practices, Research & Training [573]

3.1.5.6. Impact

Size

- One Center for 40 M population against one for every 0.05 M population in USA
- 372 M population covered in 9 States (increased reach of health care in rural , hilly and tribal areas)
- Trained 35,650 people (11,500 - EMTs, 10,000 – Pilots, 3,100 - Doctors, 2,100 - Nurses, 6,800 - First Responders and AHA/ ITLS Certification for - 2,150)
- 12,170 + emergencies handled per day (9.3 Million cumulative)
- 2,600 Ambulances - 4.5 trips a day
- 15,900 + GVK EMRI Associates

Speed

- Went live in less than 4 months from signing MoU
- 91% calls taken in first ring
- < 15 minutes (urban) and < 25 minutes (rural) Ambulances reached

Type of Emergencies and Lives saved
- Pregnancy related - 29%, Vehicular Trauma – 18%, Acute Abdomen – 13% Cardiac – 4%, Respiratory – 4%, Suicidal – 2%, Animal Bites 1%
- 300+ lives were saved per day (247,021 + till now) and 11,870 victims per day received timely, high-quality pre-hospital care

Costs
- Cost per ambulance trip Rs. 600 to Rs. 700 against $ 600 to $700 in USA

Qualitative Outcomes
- Successful PPP
- Well documented systems, impressive EMT training, high order management competence
- A historic landmark in health care delivery system
- Built more trust in the health system as a whole
- Increased institutional deliveries and reduced maternal mortalities by 20 – 25%
- A model for replication across the Country in any state

3.1.6. One of the Most Innovative Company of the World: 3M

The 100 year old organization, Minnesota Mining and Manufacturing Company (3M) generates nearly $31 billion in revenue selling over 55,000 products, employing roughly 89,000 people and operations in more than 70 countries. [610] [614] [615]

3.1.6.1. Global Innovation Company

3M is a **global innovation company** that has remained under the radar for its long-term innovation plans and successes. With $30 billion in sales and products sold in nearly 200 countries, 3M has made significant contributions to the health care, communications and office business -- including bringing some of the world's most recognizable brands, Post-it Notes and Scotch tape, to market. The root of 3M's success is its **business model**; to foster organic growth by **inventing entirely new, market-changing products**. These disruptive technologies have **not only led to new products but to the creation of new industries**. In order to foster this growth, 3M has always emphasized the important of research and development (R&D) to which the company dedicates six percent of its yearly revenue. Although a high percentage in R&D spending does not guarantee success, 3M is doing very well. 3M reached an **innovation milestone** with the company's total number of **patents past the 100,000 mark**. [604] [614]

FORTUNE -- 3M is everywhere. That's the point George Buckley, the chairman and CEO of 3M, is trying to make as he talks about his favorite subject, inventing things. Last year, he says, "**even in the worst economic times in memory, we released over 1,000 new products**." Apple and many others couldn't do what they do without 3M. The St. Paul Company produces a mind-bending 55,000 products. Some of them you know -- Post-it notes, Scotch tape, Dobie scouring pads, Ace bandages, Thinsulate insulation. But most you don't, because they're embedded in other products and places: autos, factories, hospitals, homes, and offices. Scientific Anglers fly-fishing rods and Nutri-Dog chews? Yup. They also come from 3M. Somehow they all add up to a business with $23.1 billion in revenue and **$3.2 billion in net income in 2009**, placing 3M at No. 106 on the Fortune 500. It has also recovered nicely from the recession. Sales grew 21% and net income 43% in the first half of 2010. The stock? Up about 20% in the past 12 months. The company's shares have consistently outperformed the S&P 500 and other conglomerates, including GE (GE, Fortune 500). Says Buckley: "The magic is back. It is an absolute joy to behold"… In another unusual practice, 3M awards annual Genesis Grants, worth as much as $100,000, to company scientists for research. The money is allocated by their peers and is **spent on projects for which "no sensible, conventional person in the company would give money**," says Chris Holmes, vice president of 3M's abrasives division… "Our business model is literally new-product innovation," says Larry Wendling, who oversees 3M's corporate research. The company, as a result, had in place a goal to generate 30% of revenue from new products introduced in the past five years… It's safe to say that no 3M product will generate the buzz of, say, the next iPhone. But **3M has never been about inventing the Next Big Thing. It's about inventing hundreds and hundreds of Next Small Things, year after year.** [606]

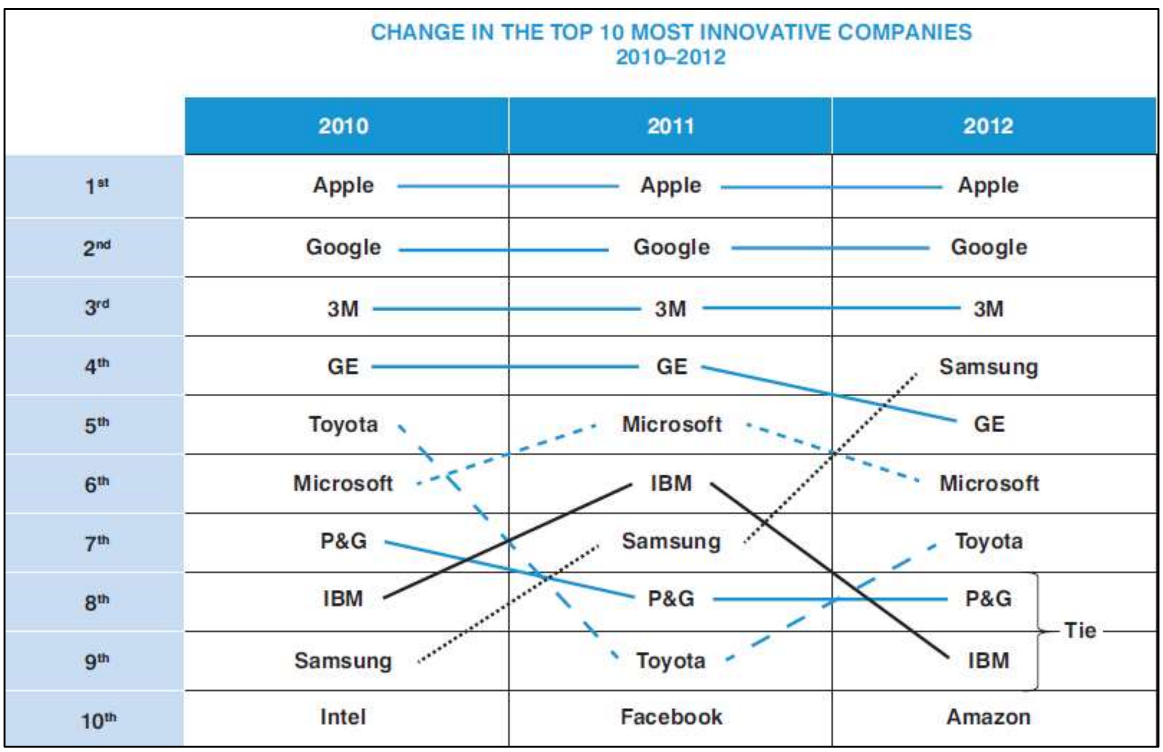


Fig. 3.14: Top 10 Most Innovative Companies of the World [601]

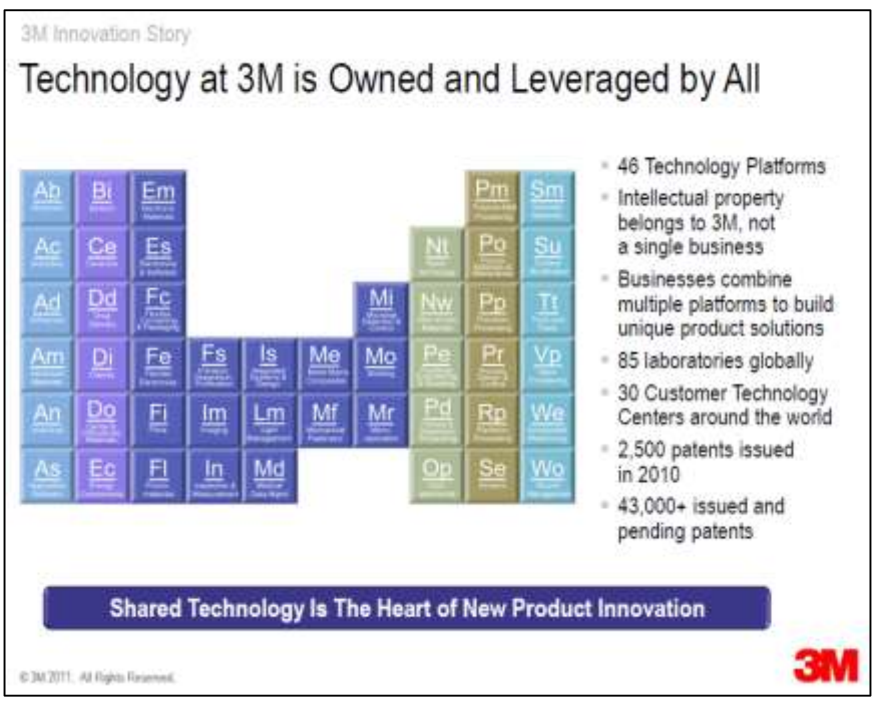
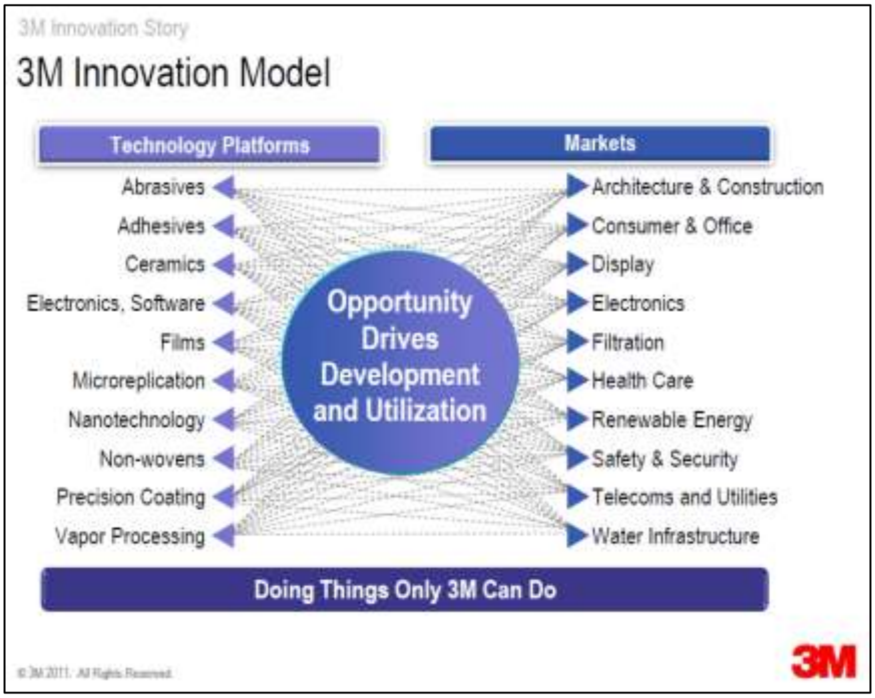


Fig. 3.15: 3M Innovations [605] [608]


3M Innovation Story
3M Innovation Model
Technology Platforms
Markets
Abrasives
Adhesives
Ceramics
Electronics, Software
Films
Microreplication
Nanotechnology
Non-wovens
Precision Coating
Vapor Processing
Opportunity Drives Development and Utilization
Architecture & Construction
Consumer & Office
Display
Electronics
Filtration
Health Care
Renewable Energy
Safety & Security
Telecoms and Utilities
Water Infrastructure
Doing Things Only 3M Can Do
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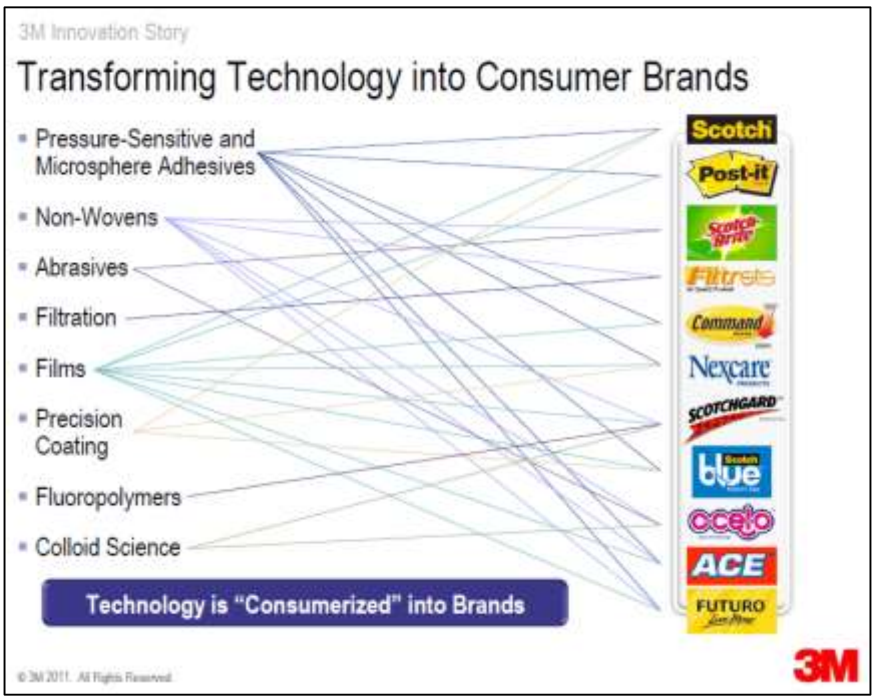
3M


3M Innovation Story
Transforming Technology into Consumer Brands
Pressure-Sensitive and Microsphere Adhesives
Non-Wovens
Abrasives
Filtration
Films
Precision Coating
Fluoropolymers
Colloid Science
Technology is "Consumerized" into Brands
Scotch
Post-it
Scotch-Brite
Filtrete
Command
Nexcare
SCOTCHGARD
blue
ACE
FUTURO
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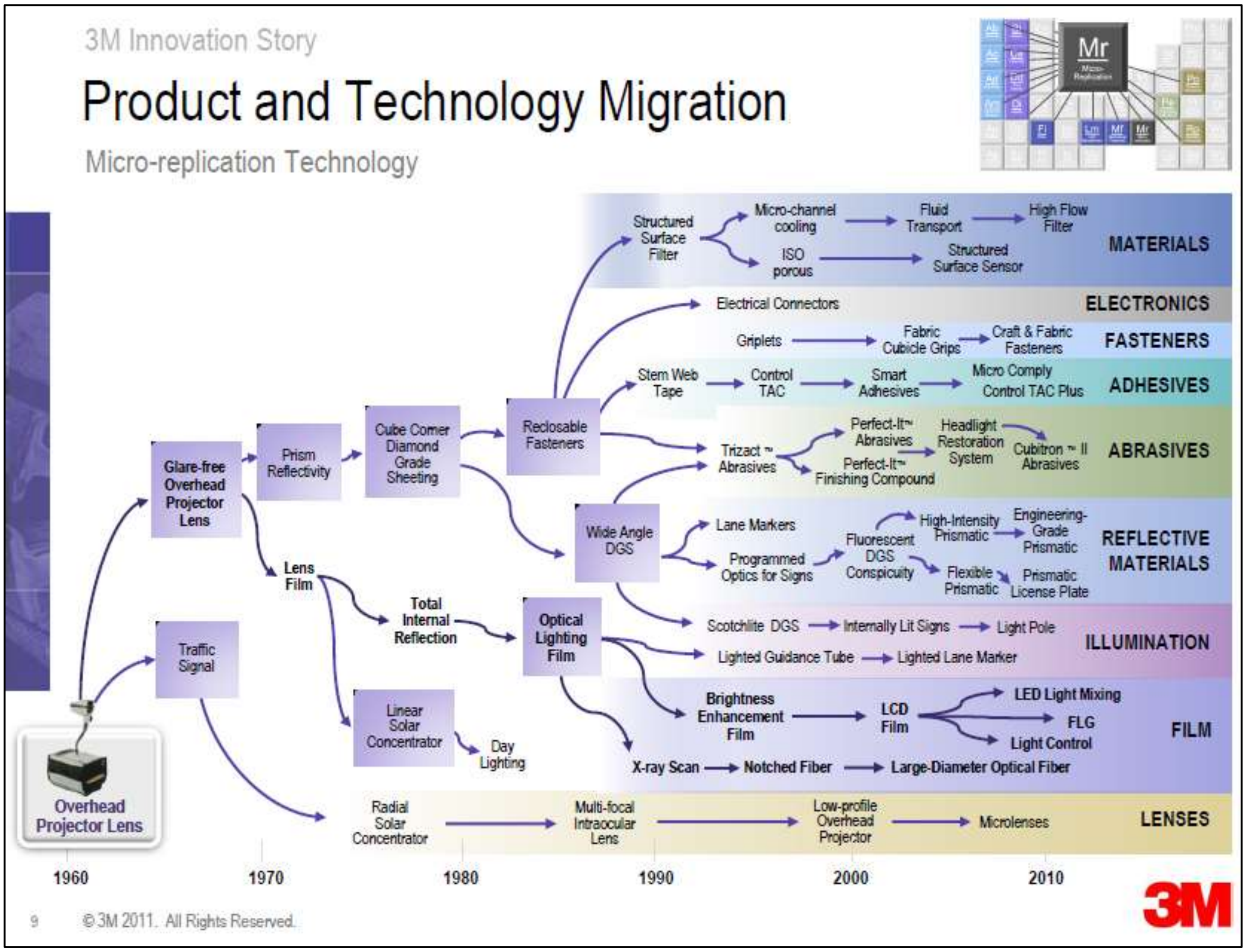


Fig. 3.16: Unique Business Model of 3M [605]

Year	Major Innovation by 3M Corporation
2012	3M and Gossamer Space Frames unveil the world's largest aperture trough using 3M™ Solar Mirror Film 1100 for concentrated solar power.
2008	3M scientists develop a breakthrough ultra-compact, LED-illuminated projection engine for integration in personal electronic devices.
2000	3M grows portfolio of light management products that make electronic displays easier to read.
1995	3M introduces the first metered dose asthma inhaler free of ozone-depleting chlorofluorocarbons.
1991	3M introduces Scotchshield™ window film, shatter-resistant, heat- and cold-resistant window protection.
1985	The U.S. Food and Drug Administration approves the sale of 3M's Tambocor™, a drug that controls irregular heartbeats.
1985	First refastenable diaper tapes introduced by 3M.
1980	Canary Yellow Post-It® Notes are introduced nationally in the United States.
1979	Thinsulate™ Thermal Insulation introduced.
1970	New products include Scotchban™ Paper Treatment to protect food packaging and 3M box sealing tapes.
1969	3M products are used in the first moon walk on July 20; Astronaut Neil Armstrong leaves a footprint on lunar dust in boots made from Fluorel™ synthetic rubber from 3M.
1967	3M develops the first disposable facemasks and respiratory protection products.

1961	Scotch® Magic™ transparent tape introduced.
1960	Micropore™ surgical tape, the first hypo-allergenic tape, is introduced and transforms 3M Health Care business.
1956	3M introduces Scotchgard™ fabric and upholstery protector to the textile industry.
1954	U.S. Post Office fleet vehicles carry Scotchlite™ reflective decals for traffic safety.
1954	RCA uses Scotch magnetic tape to record TV programs for the first time.
1948	3M's first nonwoven product — decorative ribbon for gifts introduced.
1945	Supported by Bing Crosby, 3M Sound Recording Tape revolutionizes the entertainment industry.
1937	The first successful test of reflective tape coated with glass beads is conducted.
1930	Scotch® cellophane first introduced.
1925	Scotch® masking tape and the Scotch® brand tape
1921	3M Wetordry™ Waterproof Sandpaper — the world's first water-resistant coated abrasive
1906	First sandpaper sale
	3M initially developed the Pentamix™ Automatic Mixing Unit technology for dental application with crown moldings. Recognizing that such technology could be applied to solve similar challenges in automotive body shops, 3M shared this technology across divisions. 3M Dynamic Mixing System is now a highly profitable product line for 3M's automotive business.
	Reflective materials (such as 3M™ Diamond Grade™ Reflective Sheeting)
	Abrasives (3M™ Trizact™ Abrasives)
	Scotch™ Fur Fighter™ Hair Remover
	Various optical films (3M™ Brightness Enhancement Film)
	Adhesives (3M™ Comply™ Adhesive used in graphics and automotive blackout films)
	Microneedles used in transdermal drug delivery products
	Filtek™ Supreme, a dental product that easily matches natural tooth color, was a huge risk for 3M because it utilized nanotechnology at a time when its success was largely unproven. The risk paid off. 3M is now a leading dental composite provider around the world.
	Multilayer Optical Films. 3M's Multilayer Optical Films have grown into an entire light management technology platform that is utilized in multiple 3M products sold in five different divisions.
	3M tinkered with 3M™ Scotchlite™ Reflective Material for eight years before perfecting the technology. Over the decades, its uses multiplied and spurred the creation of its own division in 1943, grossing about $10 million by 1953. Today, Scotchlite reflective material is still a profitable product for 3M's Safety, Security, and Protection Services Business, as well as for the Industrial and Transportation Business.
	Large Aperture Trough (LAT) 73 uses 3M™ Solar Mirror Film 1100 as a reflective surface and a frame support structure custom designed by Gossamer Space Frames. The result is an easy to assemble parabolic trough collector with the largest working aperture and the highest geometric concentration ratio in the world today.
	Introduced in 2009, the 3M™ Littman® Electronic Stethoscope Model 3200 uses Bluetooth technology to wirelessly transfer heart, lung and other body sounds to software for further analysis.

Table 3.1: Major Innovations by 3M (1906-2012) [616]

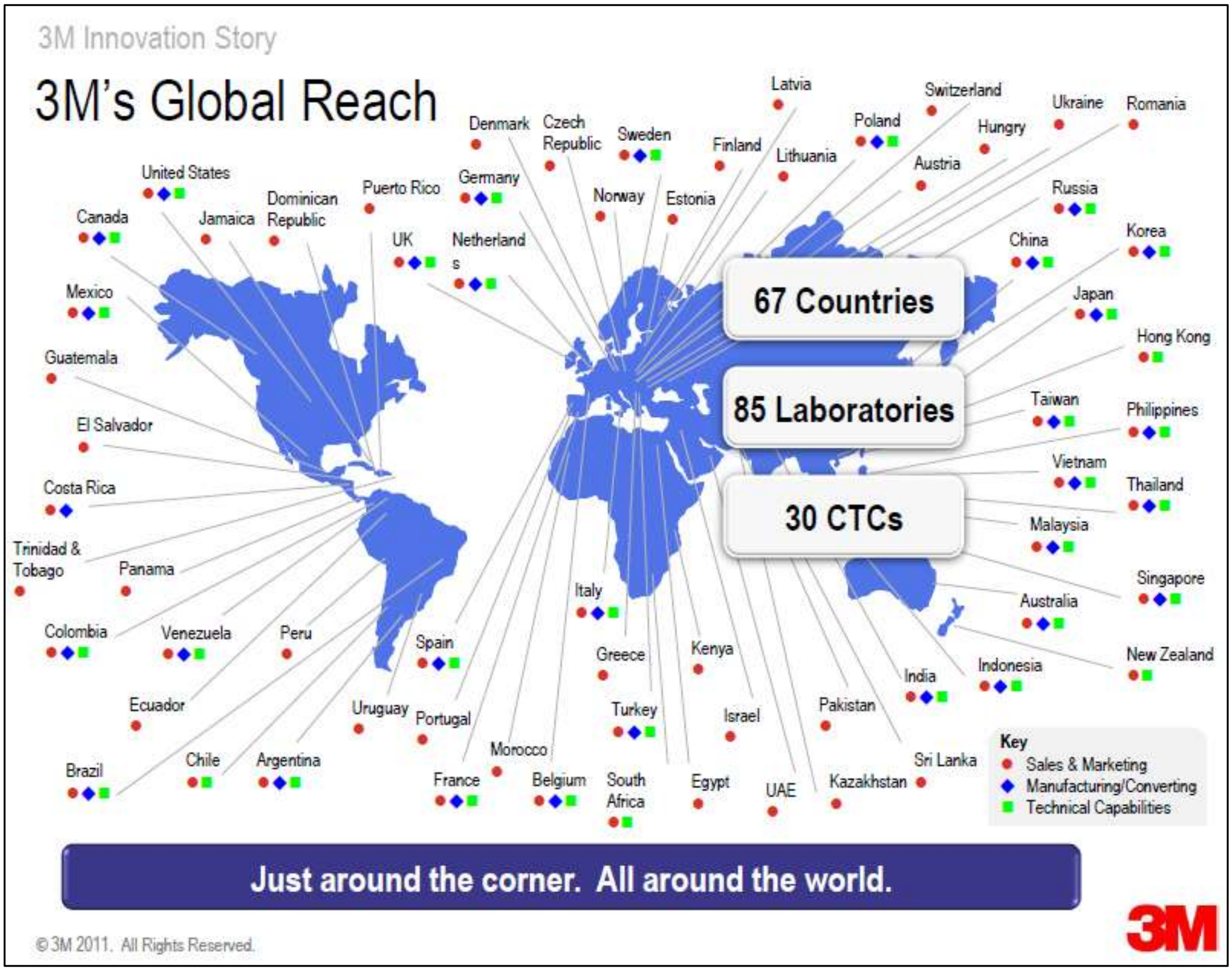


Fig. 3.18: 3M Global Reach [605]

3.1.6.2 New Approach

- 3M takes a long-term approach to the new product development process by creating a culture of innovation that encourages risk-taking, tolerates mistakes made along the way, and rewards achievement. A culture of innovation means that senior management encourages employees to spend a significant portion of their time on products and research that go beyond their usual scope of responsibilities. This involves hosting ideation sessions in which the innovation champion creates an environment of trust and openness. Only by breaking out of their usual comfort zones can teams create truly disruptive technology. [604]
- As part of the company's holistic innovation strategy, 3M focuses on developing disruptive innovations outside of the current existing portfolio. In 2008, 3M began strategically investing in startups with long-term benefit to the company, resulting in collaborations and increased technological development. These 3M New Ventures include 3M GTG digital media solutions for outdoor advertising, and Energy Inc., which monitors residential and commercial energy consumption to reduce costs. [604]

- This company has been around for just over 100 years and during that period has established a clear reputation as a major innovator. Their technical competence has been built up by a long-term commitment to R&D on which they currently spend around $1bn p.a.; this has yielded them a regular position in the top 10 in US patents granted. They have launched a number of breakthrough products which have established completely new markets and they have set themselves a consistent stretch target of getting 30% of sales turnover from products launched during the past four years. [607]
- The company presents a consistent picture in interviews and in publications – innovation success is a consequence of creating the culture in which it can take place – it becomes 'the way we do things around here' in a very real sense. This philosophy is borne out in many anecdotes and case histories – the key to their success has been to create the conditions in which innovation can arise from any one of a number of directions, including lucky accidents, and there is a deliberate attempt to avoid putting too much structure in place since this would constrain innovation. [607]
- Another way 3M capitalizes on its innovation success is by combining diverse technologies in new and unexpected ways. 3M draws upon innovative technologies from its portfolio of 55,000 products to create new solutions, such as using dental technology applied to car parts. By making these uncommon connections, the company pioneers new ways of innovating. [604]
- 3M Corporation introduces and learns a new and innovative methodology called **Lead User research** to understand future customer and market needs. A team from 3M's Medical-Surgical Markets Division applies the Lead User methodology to the field of surgical infection control and discovers **not only new product concepts but also a very promising new business strategy**. "Lead User System" is a research approach, which has reliably produced profitable new products, services and strategies. The Lead User market research method is built around the idea that the richest understanding of new product and service needs is held by just a few "Lead Users." They can be identified and drawn into a process of joint development of new product or service concepts with manufacturer personnel. [611] [613]

3.2. Frugal Product Innovation from Big Companies Case Studies

3.2.1. Tata Nano: Cheapest Car of the World

Tata Motors has spread its R&D efforts to Pune, Jamshedpur, Lucknow, South Korea, Spain and the UK where it has centres. It is the teams at these research centres that have earned for the company, and the Indian auto industry, a **number of firsts**:

- India's first indigenously manufactured car – the Indica,
- Its first sports utility vehicle – the Sumo,
- India's first indigenously manufactured mini-truck – the Ace,
- The world's most affordable car – the Nano, and
- Its latest effort – the Indica EV – an electric version of the best-selling small car for European markets. [602]

3.2.1.1. Patriotic Vision

Nano - the Dream Car of Ratan Tata, is a rear-engine, four seater Passenger Car from the house of Tata Motors for "Two-Wheeler" segment of the society. That is, affordable to the potential customers with lower income group. The Tata Nano is a signal that India will indeed compete as a technology leader in manufacturing.
The car was the result of a five year research and development project carried out by Tata Nano development team. While developing the car, Tata Motors and its suppliers constantly made efforts to reduce the costs while ensuring quality of each and every component including engine, steering, wheels, tires, windshield washing system, gear shifter etc. [584]

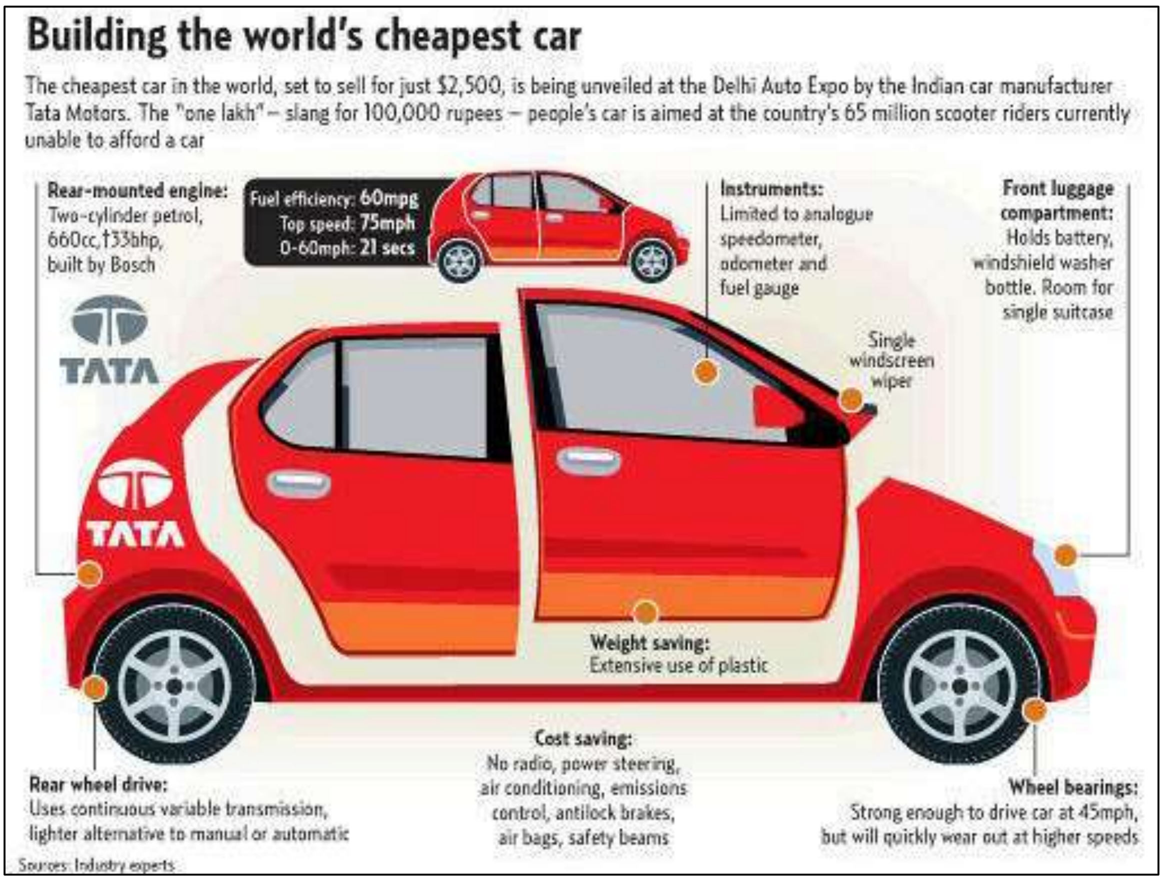


Fig. 3.19: Tata Nano Car [209]

Fig. 3.20: Tata Nano Car: What makes it so cheap? [581]

The project was given to Mr. Girish Wagh & his team included another innovative person Mr. Narendra Jain who was credited with the 1st gasoline engine made by the Tata's. The main driving factor for re-engineering & innovation was low cost. In some of the cases the cost dropped by 60% due to their out of box thinking. The result was, Tata Group ranked the 6th in the Business Week-B&G 2008 listing of the world's 25 most innovative companies.

It's a Puzzle for the developed world: How can a company in the developing country make a new-to-the-world innovation in spite of number of weakness?

3.2.1.2. Full of Innovations: Complex Product with More Than 10,000 Components

- The interesting challenge here was that aiming for a very low cost car meant the entire organization had to be leaned down - not just manufacturing, but materials, design, human resources, and so on. The team has taken the benefit of best practices from other industries such as cycle manufacturing or PC manufacturing that involves mass manufacture and assembly.
- Development started by deciding on an extremely low price point. Engineers did not try to make an existing model cheaper; instead they started from scratch, with a mandate to challenge all existing assumption about car production in order to achieve the low price.
- By offering a car at a much lower price, the Nano opened the market for a whole new category of consumers. The Nano is not aimed at those who can afford a regular car, but rather it makes it possible for families that so far have only been able to afford a two-wheeler to buy a car. Even if the Nano is very simple, it's better than balancing the entire family on a scooter.

- Taking into consideration the needs of the project, the design team went sourcing for the right suppliers and vendors who had the capacity and capability to supply to this project. They used the help of a company called Ariba Inc. who provide on-demand spend management solutions, to achieve the right combination of tier 1 suppliers. These suppliers were also initiated into the design process from the early stages itself. The Tata Nano team settled for about 100 tier 1 suppliers out of the thousand others to whom invitations were extended based on their expertise, reliability and capability in terms of being able to deliver large quantities.
- TML's top management decided to implement "concurrent engineering in real time" by integrating component suppliers very early on in the process of product development and about 800 component suppliers were approached. Rather than providing them with pre-defined technical specifications, TML extended an invitation to contribute their own ideas for this unique project. About 70-80% of the suppliers decided to participate in the product development process. TML also tapped suppliers of two- wheelers in order to identify possible analogies and synergies. In a significant departure from the norm, more than half of all the components sourced were allowed to be developed as proprietary technology of the respective supplier to enable tapping of other sources of revenue and thus further reduce costs. Companies like Bosch have already made use of this opportunity by transferring components to other carmakers.
- Apart from Bosch, several domestic and global suppliers, such as Continental AG, Denso, Sona Group and Tata Johnson Controls Automotive contributed to the Nano project with their own radical innovations. Final touches to the car were given by Italy's renowned Institute of Development in Automotive Engineering (I.D.E.A.). According to TML's Annual Report for FY 2010-11, technology for development and application of a two cylinder common-rail diesel engine for small passenger cars (and small commercial vehicles) was imported from overseas. Similarly, technology for "design and development of infinitely variable transmission based on full toroidal traction-drive variators for various vehicle platforms" has been imported. Apart from this many Component suppliers are involved like Emcon technologies (exhaust system)(US), Lumax Lighting (US) Tail light fixtures, GKN (UK) Driveshafts etc.
- After number of experiments they built an optimal engine of 624cc with a 34 bhp which gave to another innovation of high pressure die cast engine in India. The beauty of the Nano's engine is that it has become a benchmark on cost, triggering low-cost product development across the global automotive industry.
- Door handles – 70% less parts than one of the cheapest European cars
- Hollow steering shaft – lesser weight: In the Nano, the steel rod of the steering was replaced with a steel tube. This helped to reduce the weight of the car. Rane Group, the supplier of these tubes, redesigned them to make them of one piece instead of the usual two pieces.
- MRF tires - redesigned to bear extra weight on the rear
- The wheels for the Tata Nano were supplied by Wheels India, promoted by the TVS Group. The company developed a lighter wheel as compared to other passenger cars in India.
- Seating Systems and Interiors: The seating systems were supplied by Tata Johnson Controls Automotive. The front seats of the Nano were based on a single support structure as an alternative of 'individual rail'
- In order to reduce the weight of the car and save costs, the Engine Induction System was made of plastic instead of aluminum
- It emits just 103 grams of carbon dioxide per kilometer driven, compared with its nearest competitor, which emits 130 to 150 grams per kilometer

- Plastics & adhesive replaces welding
- Got the suppliers to establish base near the factory, extremely good supply chain they made "Completely Knocked-Down" kits (CKD) so that the distributors could assemble them at their own workshop.
- To enable cheaper assembly they glued the parts instead of welding them
- One of the most significant dimensions of innovation is its modular design. The Nano is constructed of components that can be built and shipped separately to be assembled in a variety of locations.
- The Nano is much lighter than comparable models as a result of efforts to reduce the amount of steel in the car (including the use of an aluminum engine) and the use of lightweight steel where possible. The car currently meets all Indian emission, pollution, and safety standards, though it only attains a maximum speed of about 65 mph. The fuel efficiency is attractive—50 miles to the gallon.
- A lot of features that Western consumers take for granted—air conditioning, power brakes, radios, etc.—are missing from the entry-level model
- The car is smaller in overall dimensions than the Maruti, but it offers about 20% more seating capacity as a result of design choices such as putting the wheels at the extreme edges of the car.
- They plan to
    - Establish factory in a tax free zone.
    - Get the tax advantages on infrastructure development.
    - Get the suppliers to establish base near the factory.
    - Get special concessions from State Govt.
- The decline in the raw material costs between January 2008 and March 2009 had helped Tata Motors maintain the price target of the car
- A key strategy was to 'de–feature' unnecessary attributes – to the extent of providing only one wing mirror and only three wheel nuts per wheel.
- Innovation throughout this international supply chain was essential to achieving the Nano's cost target.
    - Tata Motors worked with Bosch of Germany to develop a new engine management system;
    - Italy's I.DE.A Institute and Trilix for styling and interior design;
    - India's Sona Koyo for lightweight steering shafts;
    - Johnson Controls of the USA for the seating system;
    - Japan's Toyo for the engine cooling module;
    - Germany's Behr for the heating, ventilating and air conditioning system; and
    - India's Madras rubber factory for tough rear tyres.
- The Tata Nano meets all government set safety regulations and goes one step further by being more energy efficient and having less carbon footprint when compared to other cars in its segment and also quite a few motorcycles. The government has also helped Tatas find land and set up their plant in Sanand, Gujarat, India.
- The development of the Nano had led to 31 design and 37 technology patents being filed. [209] [579] [580] [582] [583] [584] [586] [587] [588]

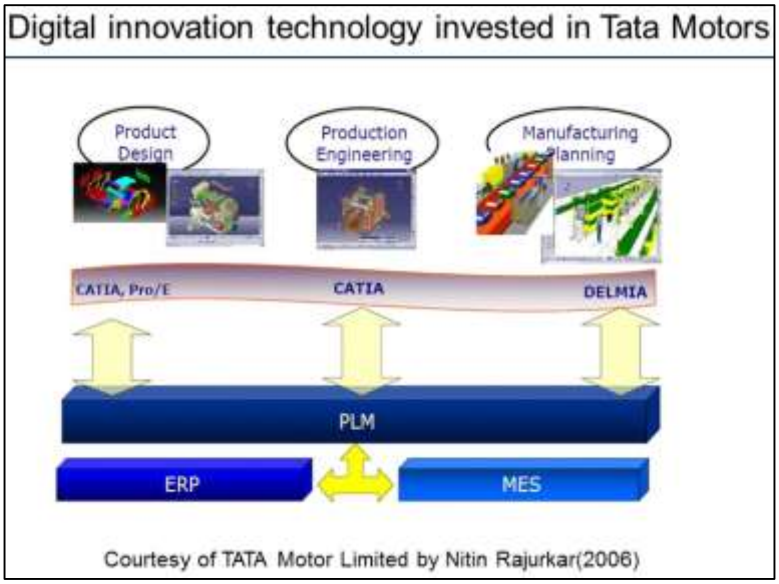


Fig. 3.21: Digital Innovation Technology invested in Tata Motors [585]

We can clearly see that in Systems of innovation approach, innovations are not only determined by the elements of the network themselves but also by the relationships that exist between the different elements of the system. These relationships are complex and are distinctive due to the presence of reciprocity, interactivity and feedback mechanisms. Hence the low price of the car can only be achieved if the design team, the suppliers, distributors, government, universities and local people all work in tandem at various levels towards this objective. The complexity of the relationships can also be considered as a challenge because when the project and the place of production are new, there is not enough information about the exact nature of these relationships. The interdependency and connectivity between the elements of the network has to be captured through empirical work which is not an easy task as it involves research into various parameters. [586]

3.2.1.3. India: Emerging as a Low Cost Innovation Cluster?

The Nano may initiate the new movement of “Ultra Cheap Car Innovation Cluster in India”. Already many companies have shown the interest in Ultra Cheap Car production in India like Bajaj, Renault, Nissan etc.

3.2.2. AMUL: 15th Top Global Dairy Organization

AMUL (Anand Milk Federation Union Limited) means priceless in Sanskrit “Amoolya”. It is managed by an apex cooperation organization Gujarat Cooperative Milk Marketing Federation Ltd. (GCMMF). The GCMMF is jointly owned by 3 million milk producers in Gujarat. Amul spurred **India's White Revolution**, which made the country the world's largest producer of milk and milk products. Dr. Verghese Kurien, founder-chairman of the GCMMF for more than 30 years

(1973–2006), is credited with the success of Amul. Amul wins World Dairy **Innovation** Awards-2014. [599]

Amul's usage of IT to pioneer the dairy movement was a strategic and planned move by its board members who realized the power of digitizing processes. The role of IT in Amul was best summed up by B M Vyas, chief executive officer, Amul (GCMMF) who told The Financial Express: "**Amul is not a food company, it is an IT company in the food business**." [598]

3.2.2.1. Amul: Building Nation

The Gujarat Cooperative Milk Marketing Federation Ltd. **cannot be viewed simply** as a business enterprise. It is an institution created by the milk producers themselves to primarily safeguard their interest economically, socially as well as democratically. Business houses create profit in order to distribute it to the shareholders. In the case of GCMMF the **surplus is ploughed back to farmers** through the District Unions as well as the village societies. This circulation of capital with value addition within the structure not only benefits the final beneficiary – the farmer – but eventually **contributes to the development of the village community**. This is the **most significant contribution the Amul Model cooperatives has made in building the Nation**. [600]

3.2.2.2. Huge Growth Rate - 32.1% and Turnover - $4.2 Billion

GCMMF which markets the extremely popular Amul brand of milk and dairy products has registered highest ever growth of 32.1%, to achieve **turnover of Rs. 18143.46 crores during 2013-14**. Results of the apex body of dairy cooperatives in Gujarat were declared on 15th May 2014, in the 40th Annual General Meeting of GCMMF. The organization which symbolizes 'taste of India', managed to achieve impressive 23% cumulative average growth rate (CAGR) over the last six years by **leveraging on several marketing and technological innovations** as well as enhanced distribution reach. In fact, the group turnover of GCMMF and its constituent Member Unions, representing unduplicated turnover of **all products sold under Amul brand was Rs. 25500 crores (Rs. 255 Billion)** or **US$ 4.2 Billion**. During the last four years, GCMMF has ensured 59% increase in milk procurement price to its farmers, resulting in 46% growth in milk procurement during the same period. By continuously offering most remunerative price for milk to its dairy farmers, GCMMF has incentivized them to enhance their investment towards increasing milk production. [593]

Its daily milk procurement is approximately **13.18 million lit per day** from **17,025 village milk cooperative societies**, 17 member unions covering 31 districts, and 3.23 million milk producer members. In 2013-14, the total milk collection is **4.79 billion liters**. [596]

Fig. 3.22: Amul Turnover Rs.18143 Crore in 2013-14 [593]

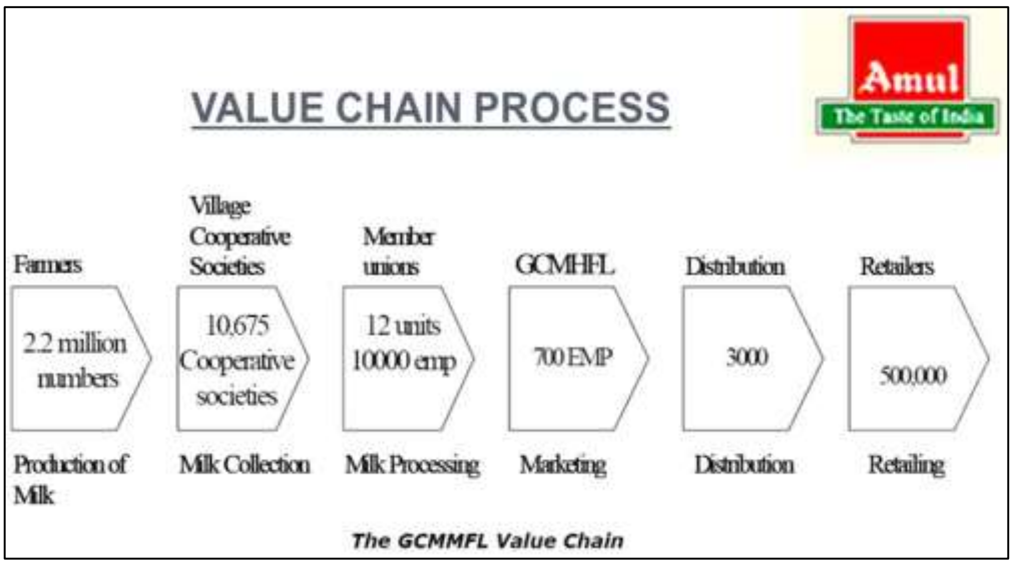


Fig. 3.23: AMUL: Value Chain [592]

Fig. 3.24: Amul products [592]

Amul has been the first dairy in India to get accredited with certification of ISO 2200:2005 & ISO 9001 for its operations and plants. Further Amul has set an example that village Dairy Co-operative Societies could also achieve this milestone as these societies are accredited with ISO 9001:2000 – a remarkable achievement in the history of India. [594]

3.2.2.3. Awards and Recognitions

Amul wins World Dairy Innovation Awards – 2014. Some of the other awards are the Best Productivity Performance Awards for three consecutive years from 1985 and Sustained productivity Performance Award in 1988-89 from National Productivity Council, Government of India, Indian Merchants' Chamber Award - for Outstanding Performance in the field of R&D of Food Processing Industries Based on Agricultural Products -1988, again Best Productivity Performance Awards 1994-99 from National productivity Council, G. D. Birla International Award - Outstanding Contribution to Rural Upliftment, Sahkari Vikas Ratna Award – awarded on the occasion of Indian Co-operative Centenary Celebration for the outstanding contributions in the field of Dairy Co-operative movement in Asia – 2005, National Energy Conservation Award – 2009 from Ministry of Power, Government of India. [594]

3.2.2.4. Innovative Use of ICT and Various Technologies

To understand the innovation at Amul, please watch the video "Akashganga Automatic Milk Collection System" at YouTube.

- The newly unveiled **ATM-style milk vending machine** let user experience the real-feeling of diary milk directly from the machine tap. This innovative product is one of its kind all over the country. The machine has been designed in such a way that it senses only ten rupees (Rs 10 currency note) before it can dispense one pouch of milk from its opening at the bottom.

Fig. 3.25: AMUL Milk ATM machine [589]

- **Spoken Web** is the most **important technology innovations developed in IBM's research labs** and Amul is using it for serving over 2.7 million milk farmers. For becoming a more agile enterprise prompted Amul to sign a 10-year IT outsourcing contract with IBM, estimated to be worth around **Rs 100 crore**. Amul Dairy is the first dairy union to launch - **Amul Awaz Setu** - a **spoken web service to connect its lakhs of farmers** spread in thousands of villages more closely to the dairy union. **Designed by IBM**, farmers can get their mobile or telephone numbers registered on toll free number. A set of technical information starting from price paid per kilo fat to animal husbandry schemes will be available at the fingertips of the pouring members of the union. "Our objective is to empower our milk farmers with information which is relevant to them and served in a language that they understand," Amul Dairy's managing director Rahulkumar Shrivastav told Times of India. Once the project becomes fully operational, the dairy hopes that over one lakh members will get connected directly to the dairy union through this technology. "With this technology, we want to make the milk producers aware of different logistics and subsidy schemes of the union with periodic updating. Also, they will be provided awareness information in an interactive mode to prevent occurrence of diseases like Theileriosis and Brucellosis amongst cattle," said Rahulkumar, adding that members can also educate themselves to carry out first aid treatment of their animals without assistance. To provide expert guidance, questions from milk producers' will be recorded and answers by expert veterinarians will be delivered within 24 hours. [590] [591]
- The milk collection center at village cooperative societies, were first **automated**. [592]
- Amul is also using **Geographic Information Systems (GIS)** for business planning and optimization of collection processes. [592]
- **Data analysis software utilization** for milk production estimation and increasing productivity. [592]
- VATS network between all the level of distribution network and GCMMF. [592]
- The company zeroed in on **ERP** – SAP as means to keep pace with dynamically changing business environment. TCS was hired to guide them in its implementation. The project was named as Enterprise wise integrated application system (EIAS). Amul start implementation of ERP in phases. **Automatic milk collection system units** (AMCUS) at village society were installed in the first phase to automate milk production logistics. AMCUS facilities to capture member information, milk fat content, volume collected, and amount payable to each member electronically. The customized ERP- EIAS has been implemented across the organization integrating various operational departments. **AMCUS has drastically reduced the process time** for paying milkmen after milk collection to a matter of minutes from a week before that. [591] [592]
    - Before AMCUS was introduced, a milkman would go to the milk collection centre with a paper-made passbook. The passbook contained details like identification number, fat percentage of milk and volume of milk. The volume of milk was recorded in the passbook and a small sample was stored in plastic bottles for measurement of the fat content. The testing of the milk for fat content was conducted later and the milkman would be paid approximately a week later when all the data was collated. The system also had many loopholes which led to corrupt and fraudulent practices
    - Under the new system, when a milkman brings milk to collection centre, he is given a plastic card for identification. The card is inserted into an electronic reader which feeds his identification number to the attached computer. Next, the milk is weighed and the fat content of the milk is measured by an electronic fat testing machine which is also

fed into the computer. The computer instantly calculates the amount due to the farmer on the basis of the fat content and a printed slip is handed over to the farmer who collects his payment from an adjacent window. [598]

- Amul also connected its zonal offices, regional offices and member's dairies through **VSAT**s. [592]
- Indian Institute of Management – Ahmedabad supplemented **Amul's IT strategy** by providing an application software – **Dairy Information System Kiosk (DISK)** to facilitate data analysis and decision support in improving milk collection. The kiosk would also contain an extensive database on the history of cattle owned by the farmers, medical history of the cattle, reproductive cycle and history of diseases. Farmers can have access to information related to milk production, including best practices in breeding and rearing cattle. As a large amount of detailed history on milk production is available in the database, the system can be used to forecast milk collection and monitor the produce from individual sellers. The kiosk would also contain an extensive database on the history of cattle owned by the farmers, medical history of the cattle, reproductive cycle and history of diseases. Farmers can have access to information related to milk production, including best practices in breeding and rearing cattle. As a large amount of detailed history on milk production is available in the database, the system can be used to forecast milk collection and monitor the produce from individual sellers. [592]
- Movement of 5000 trucks to 200 dairy processing plants twice a day in a most optimum manner. Practicing just in time supply chain management with six sigma accuracy. Online order placements of Amul's products on the web. Distributors can place their orders on the website. [592]
- Innovation of making skim milk powder from buffalo milk for the first time in the world [599]

3.2.2.5. Impact of the "Amul Model"

The effects of Operation Flood Programme are appraised by the World Bank in an evaluation report. It has been proved that an investment of Rs. 20 billion over 20 years under Operation Flood in the 1970s and 80s has contributed in increase of India's milk production by 40 million metric tons (MMT), i.e., from about 20 MMT pre-Operation Flood to more than 60 MMT at the end of Operation Flood. Thus, an incremental return of Rs. 400 billion annually have been generated by an investment of Rs. 20 billion over 20 years. India's milk production continues to increase and now stands at 90 MMT (as of 2012). Despite this fourfold increase in production, there has not been a drop in the prices of milk during the period while production has continued to grow. Due to this movement, the country's milk production tripled between the years 1971 and 1996. Similarly, the per capita milk consumption doubled from 111 gm per day in 1973 to 222 gm per day in 2000. [599]

3.2.2.6. Lesson from Amul's Success

Amul is an example of management of **very large supply chains by adapting and integrating a variety of strategies and techniques**. This includes building networks, developing trust & values in the network, developing fair mechanisms for sharing benefits across the supply chain, coordination for operational effectiveness, innovation and new technology for gaining competitiveness. It is noteworthy that these successes were achieved within the framework of a network of cooperatives organized in a hierarchical manner. There are many lessons in AMUL's success **not only for the cooperative sector but also for firms who intend to do business in emerging markets**. [597]

Service to customers required the following: better and newer "products", "processes" that would deliver the low cost advantage to the network and "practices" that would ensure high productivity and delivery of the right product at the right time. Thus technology or knowledge that was embodied in products, processes, and practices became an important factor in delivering effectiveness to the network of cooperatives. One distinguishing feature of AMUL (in comparison with other similar cooperatives globally) is the large variety in their product mix. Producing them not only requires diverse skills but also knowledge of different types of processes. AMUL dairy led the way in developing many of these products and establishing the processes for other member Unions. Equally impressive are the achievements on process technology. While **several continuous innovations** to equipment and processes have been done at AMUL, the most significant one has been the development of processes for using buffalo milk to produce a variety of end products… AMUL's **innovations in the areas of energy conservation and recovery** have also contributed to reduction in cost of its operations. AMUL also indigenously developed a low cost process for providing long shelf life to many of its perishable products. [597]

3.3. Frugal Product Innovation from Start-Up Companies Case Studies

The economic impact of startup companies may not be significant but it can provide game changing solutions. These companies can provide solutions to critical issues and genuine problems of the society.

3.3.1. Product Innovation "Nano Ganesh": Mobile Operated Water Pump

Mr. Ostwal has developed Nano Ganesh, which is a GSM Mobile Operated Water Pump. It is the M2M application by which a **distant water pump can be controlled and monitored by a mobile phone**. [460] [461] [463] [464]

Today the students of B.E. (Electronics and Telecommunications) may feel that "It's a simple project". But Mr. Ostwal has thought about this concept in 1984. That time it was challenging concept. On the top of this, he has solved one of the most genuine difficulty of millions of farmers. Remember that "If try to address bigger Problem at appropriate time then the Solution will automatically become Very Big and appreciated throughout the world". This is the reason I have included this case study.

Fig. 3.26: Nano Ganesh: Distant Agriculture water pump can be controlled and monitored by a mobile phone. [460] [461] [463] [464]

3.3.1.1. Huge Impact

According to Ostwal's calculations, vetted by the Tech Museum in California, Nano Ganesh has so far **saved 180,000 cubic meters** of water, **1080 MW of power**, **18 tankers of petrol**, **18 cubic meters of soil erosion** and **$720,000 in labor costs** so far. His net margins for just this year are in the 15-20 per cent range. [460]

3.3.1.2. Problems Faced by Millions of Farmers in Irrigation

In some parts of India, farmers have to walk several kilometers to turn on the irrigation pumps that water their fields. With the electrical supply often erratic, they sometimes find that there is no electricity when they reach the pump. Nano Ganesh allows them to remotely check to see that there is electricity, and to automatically turn the pump on and off, all through a mobile phone. It helps the farmer avoid various difficulties in reaching remote water pumps, such as long travel over difficult terrain, bad weather, and hazardous locations. It also means growers don't have to wake up in the middle of the night, which is often the only time electricity is available, to walk the long distances to their fields. They sometimes hire workers to walk the long distances to turn the pumps on and off. [543]

There are so many imposed challenges for the farmers in operating the water pumps, like,

- Distant locations of the water pumps in hazardous areas near river, wells, ponds, lakes etc.
- Difficult terrains through dense plantation or cultivation.
- Fear of animals on the way to water pumps.
- Erratic power due to heavy density of electricity distribution in the irrigation zones.
- Night operation schedules due to availability of the power during night hours.
- Shock hazards due to wet area and electricity leakages near the water pump.
- Every season is the challenge for accessing the water pump - Rains, scorching heat, winter.
- There is a need of an operator along with a motor bike, expenses on labor and fuel etc. [461]

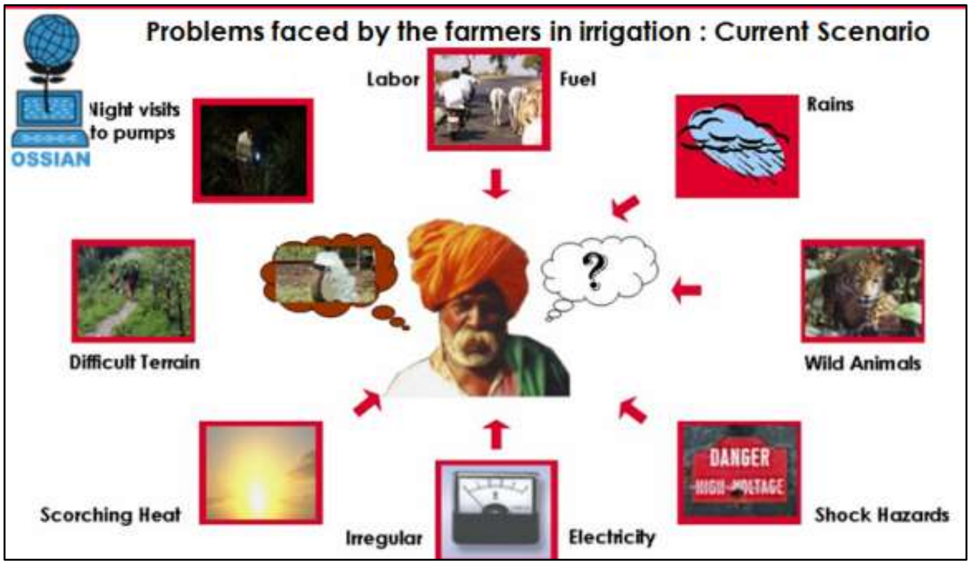


Fig. 3.27: Problems faced by the farmers in irrigation [461] [463] [464]

3.3.1.3. Popular Product

Ostwal has sold almost 12,000 units of Nano Ganesh, each costing anywhere from Rs 560 to Rs 2,500 depending on the bells and whistles required. Units are assembled from his small 16-member factory with wife Rajashree in charge of production.

3.3.1.4. Awards and Recognition

- The application was a Grand Prize winner in the Emerging Markets category of Nokia's Calling All Innovators contest, which awards new mobile applications designed to improve quality of life.
- Nano Ganesh was nominee for the Global Mobile Award for the best mobile application in the world in Social-Economic category.
- Nano Ganesh has been a winner of DST Lockheed-Martin IIGP 2011 programm.
- Nano Ganesh has been selected for recognition as a laureate in the Economic Development category for 2011, by The Tech Awards, The Tech Museum at San Jose, CA, USA.
- South Asian mBillionth award in environment category
- MCCIA’s Parkhe Industrial Merit Award in 2009 Pune India
- Villgro Winner of Wantrapreneur Award in the best business competition in 2009 in water category held in Chennai. [543]

US President Barrack Obama’s Chief Technology Officer Aneesh Chopra was so impressed with Nano Ganesh while being introduced to the firm during a FICCI conference on Science & Technology that he called it “among my favorite entrepreneurial success stories coming out of India” with a “very frugal approach to control farming/irrigation systems.” [461]

Nirankar Saxena, Director, FICCI said that "I think he's going to change things. Nano Ganesh is cheap, affordable, rugged, can work in all environments. It is the duty of the government to take this to the next step." FICCI is acting as a catalyst for Ostwal's company and hopes to network him in with Indian Farmers Fertilizer Cooperative's (IFFCO) program that houses 133,000 farmers—a potentially bonanza for Ostwal. [461]

3.3.1.5. Functions of Nano Ganesh - GSM

With the help of a mobile phone:

- Water pump can be controlled from any distance by a mobile or land line phone.
- A mobile network is essential near the water pumps
- A farmer can switch on-off the water pump from any place.
- He can check the availability of the power at the water pump end.
- He can understand the on-off status of the water pump.(Pump ON, Pump Off). One can check the load on / off status by a simple audio tone.
- He can be alerted by a call or SMS if anybody opens the starter panel doors.(Panel Opened)
- He can be alerted about power supply status. (Power ON, Power OFF, Power Faulty)
- Few models are keeping the data analytics of the water pump usage, viz. daily, weekly or monthly. [461]

3.3.1.6. Painful Story of Innovation

For a farmer whose fields are miles away and electricity a fickle beast, remote management becomes crucial. Ostwal got a first-hand taste of this, when at the age of fourteen he would spend three or four months a year on his grandfather's farm, 50 kilometers outside Pune. Dadaji as he was known, was an avid horse rider—a passion that he harnessed in order to travel top his fields and back. One day, a wound that was a result of a horse riding injury became septic and then gangrenous. The doctors eventually had to amputate the old man's leg above the knee. This didn't stop the indefatigable Dadaji from patrolling his orange fields daily, which he did with the aid of a roughly hewn stick. **Orange crops require regular watering, especially when they are a few days from being plucked, in order to maintain adequate freshness and moisture**. Ostwal says that Dadaji would **leave in the middle of the night and hobble away to his fields, switch his pump on, come back home and repeat this performance every time the electricity went off, which would be as many as seven to eight times on any given night**. "He would come back early morning, not having slept and had to then immediately begin other tasks around the farm," says Ostwal. Naturally, Ostwal was scarred by watching this theatre of the absurd every night, but intrigued enough as an aspirational engineer to try and figure out a solution. "As I got interested in this, I began to discuss this with other farmers and discovered that they all shared the same problem." Ostwal got married in 1991 which was probably the best thing that ever happened to him since his wife, Rajashree, happened to be an electrical engineer herself. He describes her as "aggressively committed to our business" and basically the boss of the manufacturing wing of Nano Ganesh. The two became co-workers and accomplices in the dream to earn a living as entrepreneurs while cracking the problem of remote management of water pumps. Their products were three to four small parts such as timers and switches. "She would assemble them in our bedroom. I would act as the marketing manager," says Ostwal. In the mid-90s, the desire for a 'remote control' amongst farmers was huge, says Ostwal and his own work focused on wireless systems. Still, there were big obstacles. Farmers didn't need the short range wireless systems that Ostwal was working with—but longer range frequencies required a license. This effectively put the nail in the coffin of a long range wireless solution since anyone expressing a desire to trigger anything from afar using a cell phone post 9/11 would have found it far easier to rob a bank than lobby for a wireless license…It also happened to be Ganesh Chaturthi and suddenly the idea to use cell phones came to him like a bolt out of the blue sky. "Within the next twenty minutes, I figured out how it would work and Rajashree and I tested it out in the next two days. It worked." [460] [461] [462] [463] [464]

3.3.1.7. Technical Details

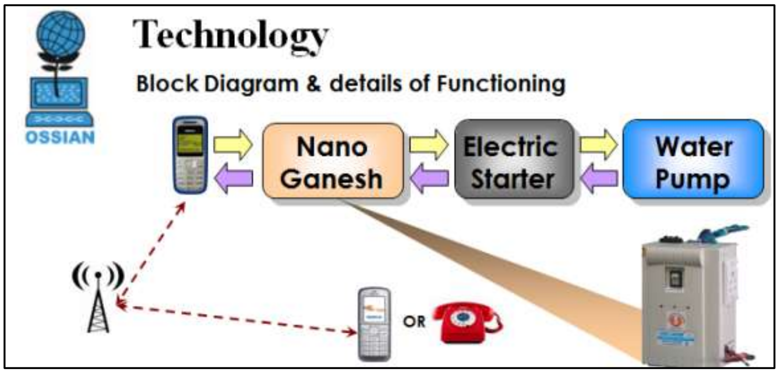
It is a GSM modem (electronics hardware) to be connected to the existing starter mechanism of the water pump and needs mobile connectivity for its operation. Being made very simple to install and operate, any illiterate person can use Nano Ganesh device irrespective of age, gender, education and language. A user (farmer) has to just procure a valid SIM card with adequate package of SMS and calls for GSM unit to be installed near the water pump. [461]

Nano Ganesh is a product that enables farmers to use mobile phones to check for electricity and monitor and control irrigation pumps to water their crops in remote locations. Developed by Santosh Ostwal in 1996, and continually improved over the years since, the product starting gaining significant momentum in 2008, and has recently won a number of high profile awards. Although a relatively inexpensive and low-tech device, the Nano Ganesh has the potential to greatly impact the lives of rural farmers, helping them to conserve time, money, and water. Ostwal's Nano Ganesh, is essentially a **circuit board that acts as an interface between a 440 volt water pump and a 3.8 volt cellphone**. In addition to exchanging packets of information that also includes letting a caller know whether there is **electricity present or not, it effectively switches the pump on or off, the trigger being the cell phone, and inevitably saves a huge amount of water**. In 2009, his idea was powerful enough to win the grand prize at Nokia's Innovator Awards held in Barcelona. [460] [460] [461] [462] [463] [464]

In addition to existing switchgear Nano Ganesh – GSM accessories (set-up in the starter panel Installation Components) are:

- Nano Ganesh GSM Modem: This modem is installed in the starter panel which are normally made of galvanized or M.S. sheets. These panels are placed outdoor in the farms or near the water pumps. There is a simple hinged door for the panel secured with lock and key arrangement.
- Antenna: There is a need of an external antenna for the GSM unit.
- Battery: The power supply to the GSM unit has been supported with additional battery back-up.
- Magnetic Door Sensor: A panel door sensor is installed in the starter panel to sense the door opening movements, so that whenever a panel door is opened, an alert SMS or call is sent to the farmer's mobile phone. [461]

Basically, it is GSM wireless controller which receives controlling commands from the user's mobile phone and sending SMS alerts to the stored mobile numbers. It comprises of state-of-the-art life tested technology for providing a feedback of power or load on-off status with the help of simple audio tones, hence making the system linguistic free. [461]



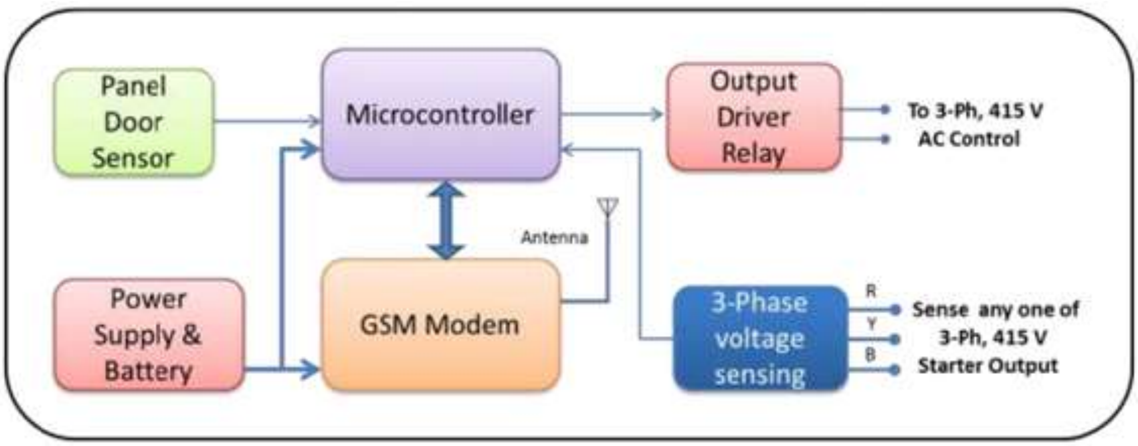


Fig. 3.28: Nano Ganesh: Mobile Based Remote Control for Agriculture Pumps [461] [463] [464]

3.3.2. Sloka Telecom: Base Stations for Telecom Towers

"Technology doesn't always have to be fantastic. It can be very basic, solving some basic problems that we continue to face. We will keep solving them," points out Sujai Karampuri, founder and CEO of Sloka Telecom, a radio access network solution provider. [554]

3.3.2.1. Most Cost Effective Solution

The traditional designs for base station are suited for Macro base stations which are quite expensive, almost **5 to 10 times more** than Sloka's compact base stations. [554]

These small all-outdoor base station units from Sloka can be easily installed directly on towers, rooftops, traffic poles and walls. These base station solutions help the operator reduce the capital expenditure by more than 50 per cent, as they do not require air-conditioning. [555]

3.3.2.2. Award and Recognitions

This product got appreciation from all corners.

- NASSCOM EMERGE 50 for 2009
- Innovations Award 2008 by NASSCOM
- NASSCOM Top 100 IT innovators 2007
- Sloka Telecom is selected by the HeadStart Foundation as the top 20 startups for the year 2008
- Mint Magazine – Ranked #1 in 10 Startups to watch for in the new year

3.3.2.3. Real Challenge

One of the challenges in the spread of broadband Internet through wireless will be the rapid expansion of wireless base stations (or, towers as they are normally called). The process of building tower infrastructure has been time consuming and expensive. In addition, the equipment used needs air-conditioning and uninterrupted power. A Bangalore-based company, Sloka Telecom, is addressing these issues, designing smaller and cheaper base stations for broadband wireless and cellular networks. Base station is the electronic equipment that sits next to a tower, transmitting and receiving radio signals for mobile phones or a wireless broadband device. [555]

3.3.2.4. Innovation Story and Technical Details

Founded in 2004, the Bangalore-based Sloka Telecom develops one of the most compact and cost-effective base stations for the telecom sector. After over 14 years of work experience, Sujai set out to solve real problems in India's telecom space with advanced, cost-effective solutions for broadband wireless, voice, and video applications, for rural and urban markets…Our base stations are the smallest and also the cheapest. They are all-outdoor base stations and can be installed on towers, poles, rooftops, traffic posts, etc. They do not need expensive AC housing and can cool itself in different weather conditions. Our base station solutions help the operator decrease his capital expenditure by more than 50 per cent. [554]

Sloka Telecom, a five-year-old startup with 33 people, has developed base stations for telecom towers that are 10 times cheaper than traditional technologies. Using existing chipsets, Sloka has created technology that uses a mere **60 watts of power**, **avoids the need for air conditioning**, and is **much smaller and lighter than existing base stations** The drastic reduction in size, cost, and energy consumption **changes the business model for telecoms**. Now, as a result, they can deploy very large numbers of base stations, provide markedly better service quality, and support higher rates of data transfer — all keys to success for the emerging WiMAX technologies. [553]

Sujai Karampuri, founder and chief executive officer of the company, says: “The traditional landline business based on copper connectivity took many decades to reach 40 million subscribers, while it took less than a decade for mobile connectivity to connect 200 million subscribers. With wireless, once the network is installed, the cost of adding new subscribers is much lower. The number of subscribers will go up dramatically once wireless connectivity kicks off. WiMAX is the best suited wireless technology and standard to provide broadband to homes, offices, enterprises and other areas. Also, WiMAX links can replace the current microwave backhaul to connect cellular towers — this is going to be a major application.” [555]

Sloka Telecom’s 5.8GHz suite of WiMAX (Worldwide Inter-operability for Microwave Access) products caters for the unlicensed frequency spectrum allowing wireless Internet service providers (WISPs) to deploy wireless broadband access networks without having to obtain frequency licenses. Sloka’s 5.8GHz suite of WiMAX products includes base stations, subscriber stations, the authentication, authorization and accounting (AAA) server and the network management system (NMS). [555]

3.4. Innovation Network: Examples

3.4.1. Example: Accenture

The Financial Services Innovation Center brings together our best thinking with an integrated network of more than 40 global Innovation Showcase Centers for specific industries or technologies; including five Accenture Technology Labs, the R&D organization within Accenture. [272]

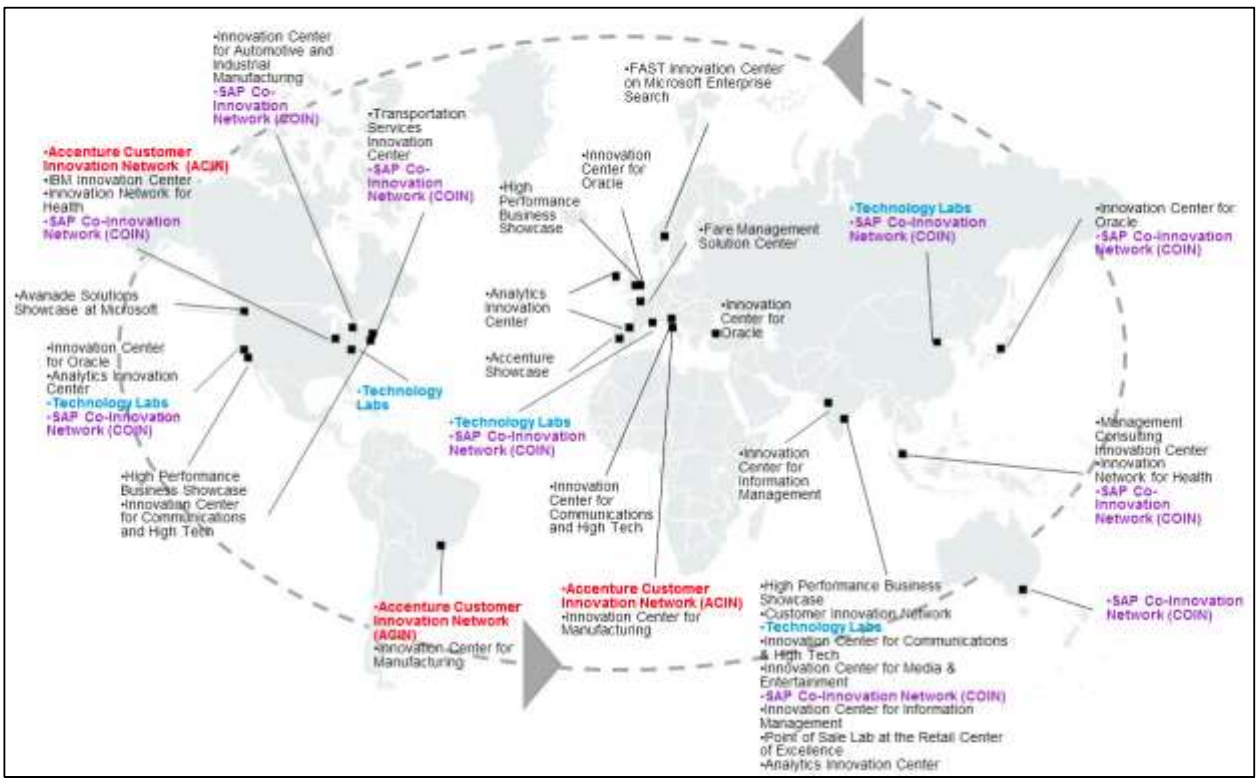
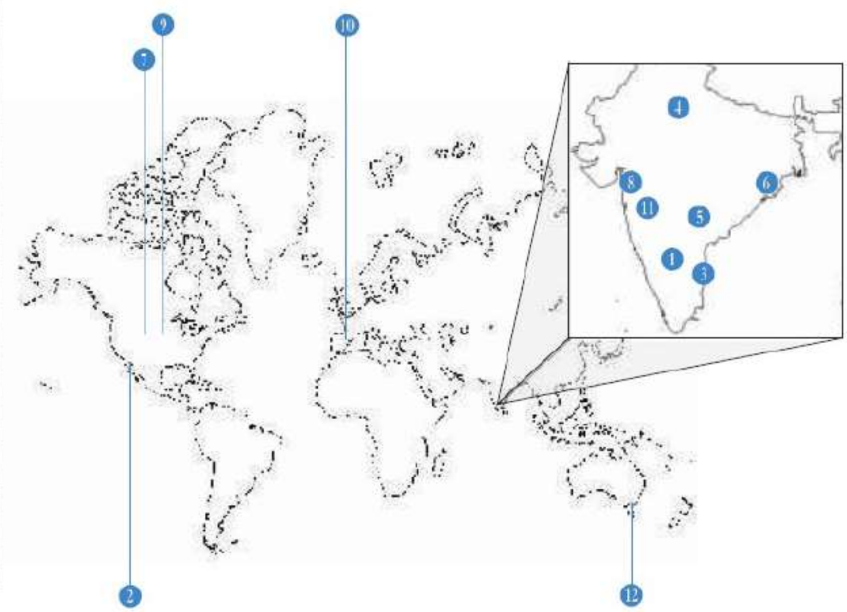


Fig. 3.29: Innovation Network [272]

3.4.2. Example: TCS

TCS Innovation Labs are working across domains and new technologies to deliver a range of solution frameworks. They work on diverse technology areas like next generation software processes, human-computer interface, bio-informatics, nanotechnologies, embedded solutions and next generation IT infrastructures. Some of its labs work on applying these technologies innovatively to create domain specific solutions in Travel and Hospitality, Retail, Telecom, Insurance, Media and Entertainment and Financial Services businesses…. The continued progress along the Globally Distributed Work GDW journey combined with the need for tapping capabilities from other companies and the challenges of innovation delivery helped Tata Consultancy Services (TCS) move to the next level i.e. 'IT Services Partner' to 'Innovation Partner'. [576]



1.	Bangalore, India
	TCS Innovation Labs - Bangalore
2.	Burbank, USA
	TCS Innovation Labs - Telecom, Media & Entertainment
3.	Chennai, India
	TCS Innovation Labs - Chennai
	TCS Innovation Labs - Retail
	TCS Innovation Labs - Travel & Hospitality
	TCS Innovation Labs - Insurance
4.	Delhi, India
	TCS Innovation Labs -Delhi
5.	Hyderabad, India
	TCS Innovation Labs -Hyderabad
	TCS Innovation Labs - Business Systems
	TCS Innovation Labs - CMC
6.	Kolkata, India
	TCS Innovation Labs - Kolkata
7.	Minneapolis, USA
	TCS Innovation Labs - Performance Engineering
8.	Mumbai, India
	TCS Innovation Labs - Mumbai
	TCS Innovation Labs - Performance Engineering
	TCS Innovation Labs - Telecom, Media & Entertainment
9.	Naperville, USA
	TCS Innovation Labs - RFID
10.	Peterborough, UK
	TCS Innovation Labs - Peterborough
11.	Pune, India
	TCS Innovation Labs - TRDDC
	TCS Innovation Labs - Engineering & Industrial Design
12.	Sydney, Australia
	TCS Innovation Labs - Banking & Financial Services

Figure 3 TCS Global Innovation Labs

Fig. 3.30: TCS Global Innovation Labs [576]

TCS has 19 **Innovation Labs** based in three countries including TRDDC's three R&D labs. TCS Innovation labs have **800 associates in R&D** and provide an environment for complex IT research in leading-edge technologies as well as in various domains. TCS labs work on areas like Life sciences, Open source technologies, enterprise architecture, wireless technologies, performance engineering, etc. TCS Innovation labs are customer aligned and metrics driven and scientists and researchers continually publish/present research papers and publications. Some of the products created by TCS Innovation labs are mKrishi, DBProdem, Jensor, Wanem, Scrutinet, SmartTest Manager, etc. [577]

With that 360-degree outlook in mind, TCS has convened a global, interconnected innovation ecosystem — the **Co-Innovation Network, or COIN** — that links businesses large and small, well-established and new, with a broad network of partners, suppliers, leading-edge vendors, outside consultants, academic institutions, and venture capitalists. The prime purpose of COIN is to create for IT and the business it supports the largest possible "funnel" of innovative and profitable ideas from numerous, collaborative sources inside and outside an organization. [576]
Matthew Palmer, Head of IT Futures at Norwich Union Life (NUL), a leader in the UK life and pensions market, stated that "What differentiates TCS is its Co-Innovation Network (COIN) approach. COIN recognizes that innovation happens everywhere – in universities, research centres, industry bodies, start-ups and so on. TCS links these innovation resources together with its own innovation labs across the world, forming a network that we can leverage, and providing a world-class delivery capability that gives us access to the latest technologies ahead of our competitors." [576]

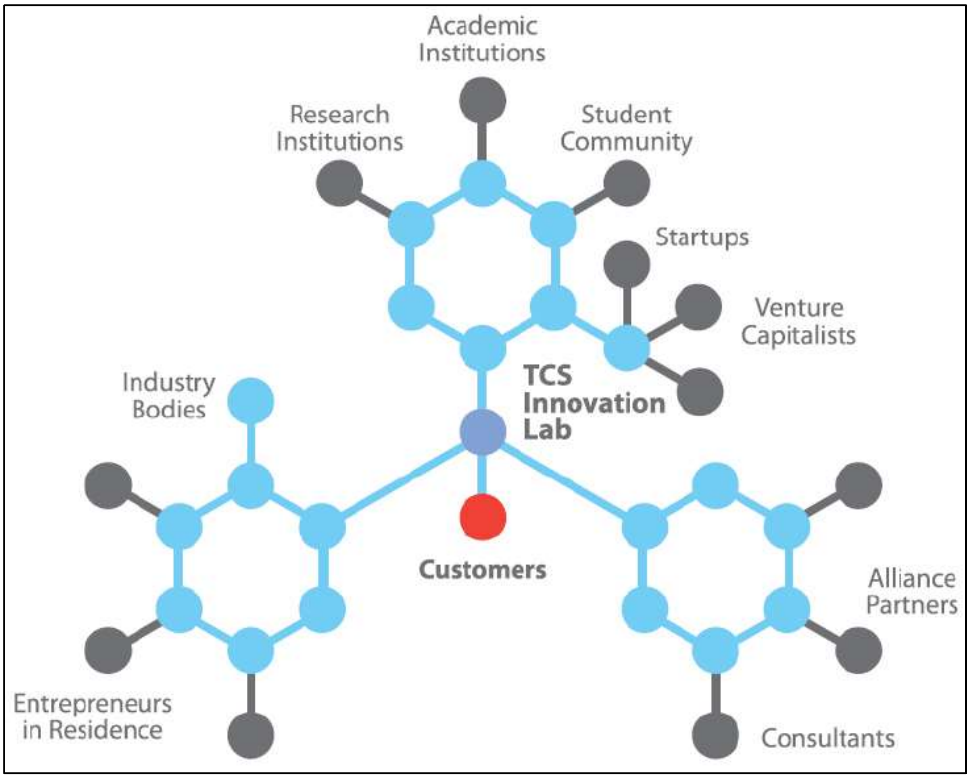


Fig. 3.31: TCS Co- Innovation Network (COIN) [576]

3.5. Innovation Management: Brief Case Studies

I would like to quote two diagonally opposite innovation management case studies. The first one is Cognizant and second one is Apple.

3.5.1. Brief Case Study: Cognizant

Cognizant Technology Solutions is an American multinational corporation that provides custom information technology, consulting and business process outsourcing services. [626]

The detailed case study of Cognizant is beyond the scope of this book. Please refer the website for this very interesting case study (**50 pages**). They have explained the Innovation Management Process with minute details. I would like to quote few points of this case study. [269]

Back in 2008, with 100s of clients and over 60000 employees and with ambitious growth, the leadership team was struggling to arrive at a suitable approach. There were more questions than answers lingering in the minds of the Cognizant Innovation Group leadership team, which had little experience in managing innovation of this scale.

- Where to begin? - Start the innovation drive from the Top-Down or encourage, excite Bottom-Up force to innovate
- Where to innovate? - Outside-the-Box or Inside-the-Box
- How to spread the message of innovation? – Blast impersonal messages to everyone in the organization or create a multi-level network and spread the message with a personal touch;
- How to energize a growing organization with 1000s of employees to continue innovate? – Mandate everyone to Innovate (push model) or encourage people to realize their potential (pull model);
- How to measure the innovation impact? – Go after the big impact innovations or take into account even the small innovations with tiny impact;
- What to measure and how to communicate the progress? – Send flashy mails to everyone in the organization or use the power of informal networks;
- What kind of rewards and recognitions to provide? - Worship a few heroes or reward behavioral changes;
- What kind of people, systems, process and structures required to support this effort? – Build a large centralized innovation organization or go for distributed innovation teams using a leveraged model;
- What might be the cost to the organization? – Ask for big budgets given that everyone is spending big dollars or experiment using a small team with a small budget? [269]

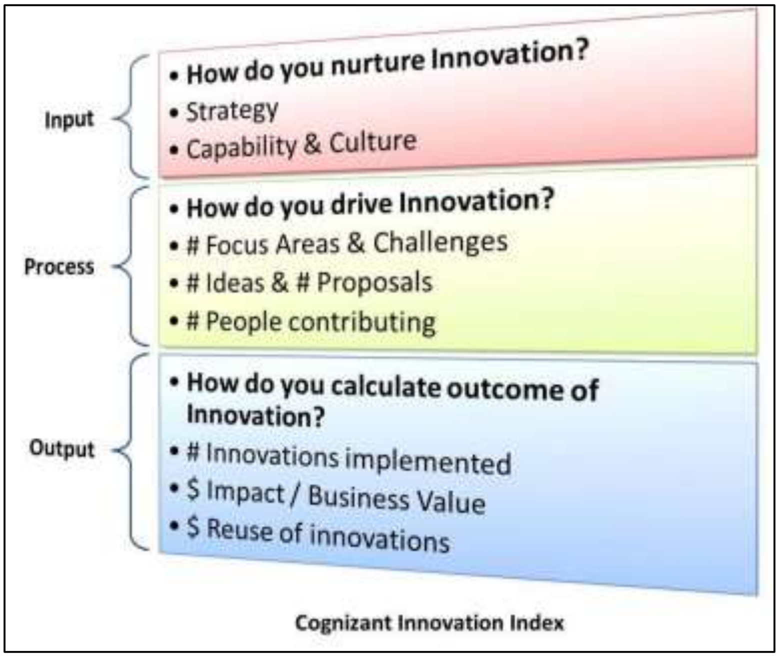
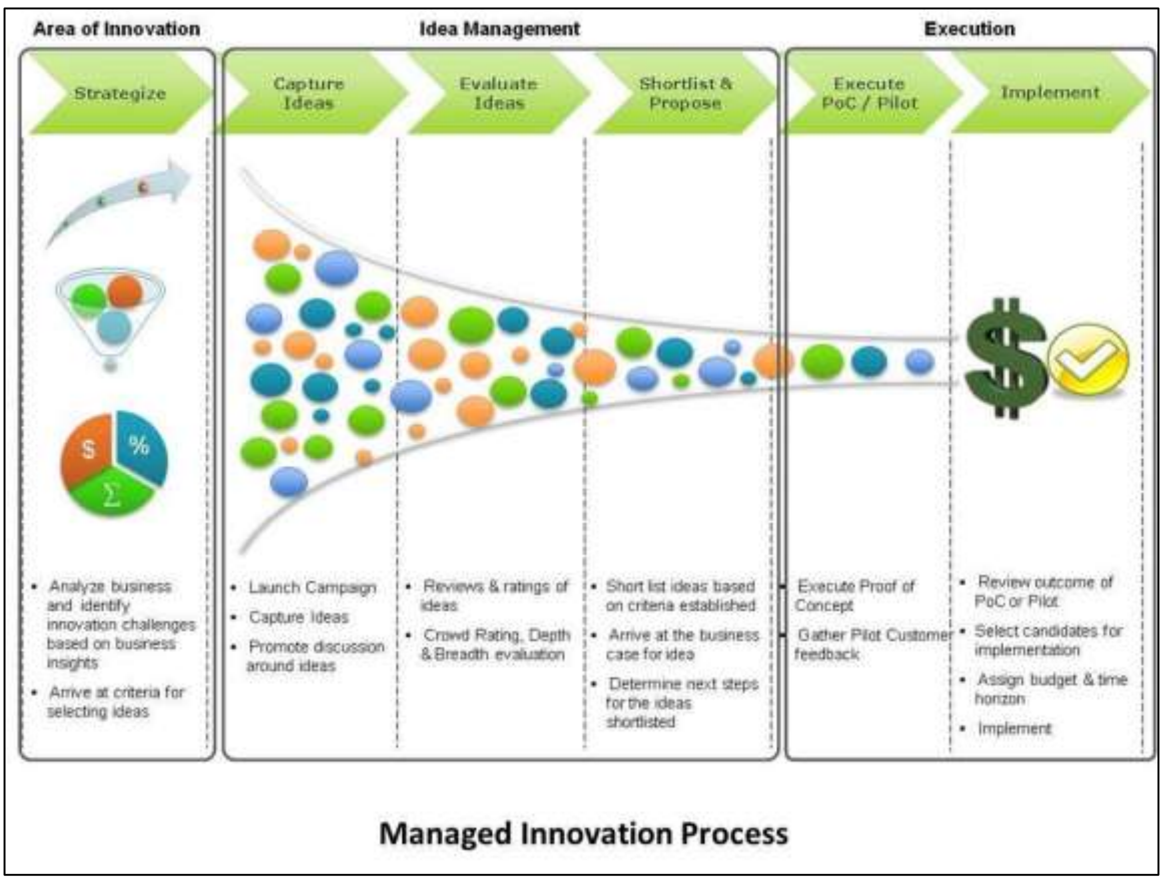


Fig. 3.32: Innovation: Input, Process and Output [269]



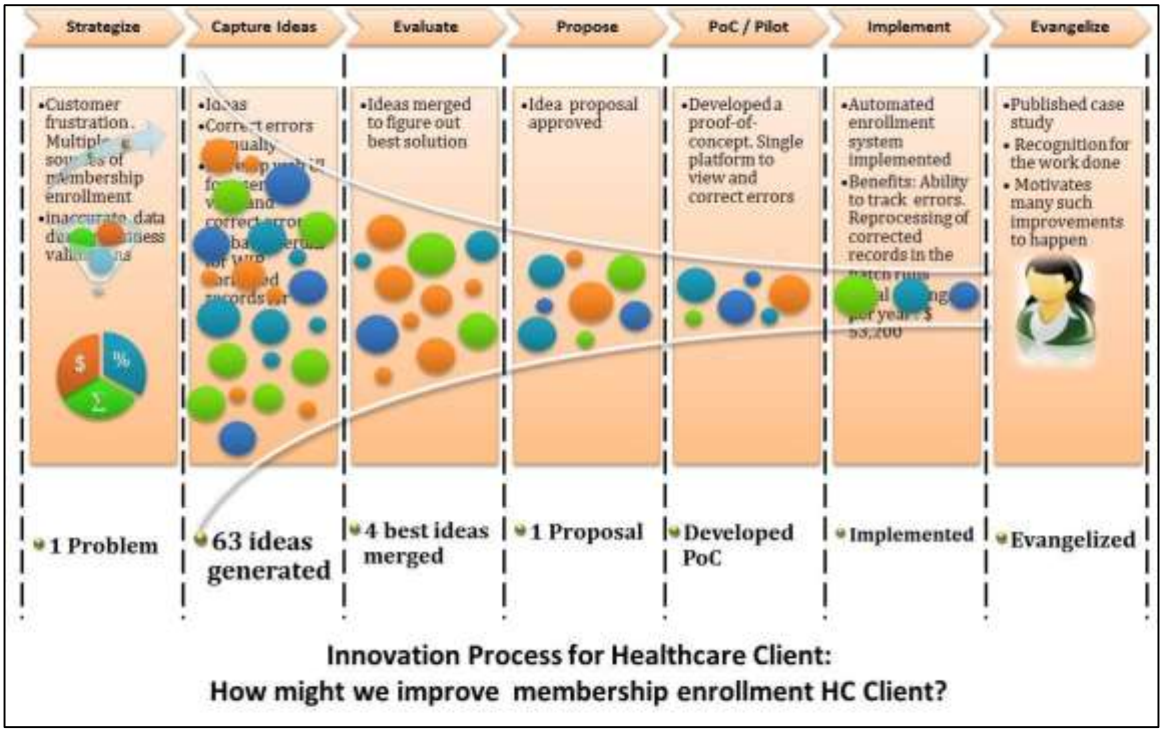


Fig. 3.33: Manage Innovation Process [269]

3.5.2. Brief Case Study: Apple

3.5.2.1. About Spectacular Growth

Apple is today the world's largest music retailer, a milestone reached just six years after the launch of its online music store in 2003. The **10 billionth song** sold on iTunes was downloaded on February 24, 2010… Since the launch of the company's App Store in 2008, Apple has become the world's largest software distributor. Thus far, developers have **created more than 425,000 applications** for the company's iOS operating system, and consumers have **downloaded more than 10 billion apps**. [628]

Success of Apple

- The iPod has 78% market share for portable music players, with over 300 million sold.
- The iPad has 75% market share for tablets
- The iTunes is the number 1 music store in the world
- 60 million Mac users worldwide, 23% market share for personal computers [491]


Since the year 2000 Apple has shown strong results
In 2000
Apple revenues were about $8 billion.
Apple posted net profit close to $800 million
In 2008
Apple revenues were about $37.5 billion
Apple posted profit of over $6 billion
Increase revenue more than 450% in 8 years…
Increase net profit more than 1700% in 10 years…
"We're armed with the strongest product line in our history, the most talented employees and the best customers in our industry. And $25 billion of cash safely in the bank with zero debt," Steve Jobs, CEO of Apple, October, 2008 Earnings
EBTIC
ETISALAT BT Innovation Center
KHALIFA
UNIVERSITY


The trend continues
In 2010
Apple revenues were over $65 billion
Apple posted profit of over $14 billion
Increase in revenues more than 800% in 10 years
Increase in revenues more than 170% in 2 years
Increase net profit more than 1700% in 10 years
Increase in net profit more than 230 % in 2 years
EBTIC
ETISALAT BT Innovation Center
KHALIFA
UNIVERSITY

Fig. 3.34: Innovation: Apple [275]

3.5.2.2. Altogether Different Approach for Innovation Management

Apple innovates through:
- Creativity and Innovation
- Innovation Process
- Innovation in Products
- Innovation in Business Model
- Innovation in Customer Experience
- Innovation and Leadership [309]

When it comes to **innovation management** it is widely argued that in today's business world it is essential to focus on both a **market-pull** and **technology-push** approach in order to ensure that the products developed are innovative and meet customer-needs. Yet **Apple doesn't conduct market research**, **nor does it concentrate on what its competitors do**. As such it has **no external focus**. It **solely focuses on a technology-push approach** and **completely relies on its intuition and perfectionism**. The reason for this, as argued by Apple's Senior VPs, is that "**customers don't know what they want, rather you have to tell them what to buy**". And as Steve Jobs put it, **if you make a really great product "then everybody will want to use it**". It is worth mentioning that a **similar approach was adopted by Henry Ford more than 100 years ago**, which as such set the cornerstone of the automobile mass market. He is reputed to have said that "If I had asked my customers what they wanted they would have said 'faster horses'". [625]

Given Apple's notion about product development it comes with no surprise that it **doesn't have a system or pre-determined process to foster innovation either**. At Apple it's all about **communication**, **open-mindedness** and **collaboration**, where **people are encouraged to express their ideas**. According to Steve Jobs "its ad hoc meetings of six people called by someone who thinks he has figured out the coolest new thing ever and who wants to know what other people think of his idea". Moreover, there are **no sequential development stages**. Rather the **emphasis lies on simultaneous** [109]

Apple's strategy of innovation is **customer centric** (altogether different way). Apple aims to provide for all basic human needs and create a desire for its customers to interact with their computer or mobile device. The goal is for the **customer to love their machines** – focusing on every little detail down to packaging. Key to this strategy is the relentless **pursuit of product improvement**. In this pursuit, **Apple maps out their product's innovation cycle 5 to 10 years into the future**. As a result, this innovation platform makes it difficult for competitors to catch up. Lastly, Apple takes a broad approach with their products – analyzing customer needs and attempting to fulfill them… Apple's portfolio approach allows the company to market a relatively streamlined number of products and see what catches on…Steve Jobs as the chief innovator is very involved in the sourcing of the initial idea. For inspiration, Apple oftentimes starts with a new idea for a multimedia interaction and designs a product that will enable that interaction. Rather than looking to solve specific customer needs, **Apple studies new ideas and how they can promote customer interaction**. By taking this human-centered approach, Apple thinks differently than their competitors and improves the customer experience. For example, the iPod was not the first mp3 player, but it was the first mp3 player that focused on simplifying the interaction between the music store, computer and player. From the outset of the innovation process, Apple utilizes Tim Brown's concept of Design Thinking – focusing on the customer's experience in design. This iterative technique results in a smoother, simpler product. The product development team is a tight-knit group that is constantly testing and retesting each other's work…Apple products are **not rolled out with beta testing**, rather they are presented in a final and perfected form (oftentimes in an extravagant presentation). A simple, beautiful, perfected product straight out of the gates is a result of a painstaking development process. **Apple's development and experimentation process is veiled in secrecy**. Steve vaguely describes their development process as "**The system is that there is no system**. That doesn't mean we don't have process. Apple is a very disciplined company, and we have great processes. But that's not what it's about. Process makes you more efficient. What we do know is that there are large cross functional teams with hands-on leaders". Even Jobs gets involved at the product development and experimentation level. The team is given a defined timeline to encourage the process. Apple engineers are famous for working 90-100 hour weeks for months at a time to hit the predetermined hurdles and deadlines…**Apple builds beautiful products that are simple to use and empower their customers through their high quality user experience**. However, Apple does not just build beautiful products, they also **build beautiful business models that capture value beyond the product**. [627]

While most of Apple's competitors have specialized in **either hardware or software**, Apple has pursued **excellence in both**. By tightly integrating hardware and software design, the company has been able to optimize system performance to the benefit, and relief, of its customers… With the possible exception of Samsung, Apple encompasses a **broader array of technological competencies** than any of its competitors. Though it does little of its own manufacturing, Apple's mastery of semiconductor design, advanced materials, batteries, power management, component packaging, application development, and industrial design gives the company a distinct advantage in launching groundbreaking products--and in controlling its own destiny... Apple's self-definition **isn't centered on a particular product or market, but on a portfolio of deep competences**. It is telling that Jobs once described Apple as the world's large "mobile devices company" (ahead of Nokia, Samsung, and Sony), and not a computer company. A decade ago, no one would have lumped Apple in with these companies--the comparisons would have been with Microsoft and Dell… Think Like an Engineer, Feel Like an Artist. [628]

3.5.2.3. Innovative Leadership

Steve Jobs is a visionary leader and acts as Apple's chief innovator. He believes that in order to innovate "You need a very product-oriented culture….Lots of companies have tons of great engineers and smart people. But ultimately, there needs to be some **gravitational force** that pulls it all together." Steve has primarily been that gravitational force. [627]

Steve Jobs, the inspired and uncompromising visionary who led Apple from 1976 to 1985, and then again from 1997 to 2011. In that latter fourteen-year period, Apple's **share price increased 110-fold**. When Jobs stepped down from his CEO post in August 2011, only two months before he would pass away, he left behind a legacy that is nearly unparalleled in business history. [628]

After 1993 though, Apple began to slip, launching a long list of failing products, and losing market share to Microsoft. In 1996, the company was on the verge of bankruptcy, and Steve Jobs was brought back into the company. Between 1997 and 2005, Steve Jobs returned Apple to a profitable state. [491]

Fig. 3.35: Innovation: Apple [275]

Part II: How to Ignite Human Brain for Innovation? How to Inject Innovation in to the Culture of the Organization?

Chapter 4: Building Culture of Innovation in any Organization to Produce Innovation

The organization includes R&D Labs (National, Industry, NGO and MNC), Industry, University, Institute of higher education etc.

*There is **no guarantee** that an innovation culture will lead to innovation, but it certainly is a **prerequisite**. [37]*

*In today's fast moving and complex global environment, the ability to innovate and deploy faster and more profitably than competitors is now a requisite for growth and success. For companies that are founded on new products, such as **Apple, the focus on innovation has always been a fundamental part of the culture**. [11]*

*Unfortunately, most companies fail to unleash their most valuable resources: human creativity, imagination, and original thinking. They lack a systematic approach to building a **culture of innovation**, and then wonder why they keep getting beaten to the punch. [12]*

"The fastest way to succeed is to double your failure rate." Thomas Watson, founder IBM

Business and technology leaders' say the most critical factor in their company's success is innovation - far outweighing wage and tax issues - according to the Cisco Innovation 2005 Study. Although most companies realize that investment in innovation is critical to long term growth of companies, there is still a fear of investing in innovation. It is considered as a high risk, high investment venture where the return on investment is not guaranteed. [576]

*"**Innovation has to be inculcated in the DNA of organizations**." - Mr. Naresh N Shahani, Founder & Managing Director, BMGI [201]*

4.1. Culture of Organization

Culture is a complex force field that influences all of an organization's processes. We try to manage culture **but, in fact, culture manages us** far more than we manage it, and it happens **largely outside of awareness**. [58]

Culture is an **ecosystem** in which **all the components are interconnected**. Building an innovative culture requires a set of new skills and behaviors among existing employees. [13]

Fig. 4.1: Importance of culture: Culture eats strategy for breakfast [56] [57]

Fig. 4.2: Is there one "best" culture? [57]

Positive aspects of culture
- Social glue
- Boundary defining
- Common sense of identity
- Facilitate commitment

Negative aspects of culture

- Can be barrier to change
- Can be barrier to diversity
- Can be dysfunctional for new business model

Take advantage of positive attributes of the culture and minimize the negative aspects to establish **the portfolio of innovative thinking**. [57]

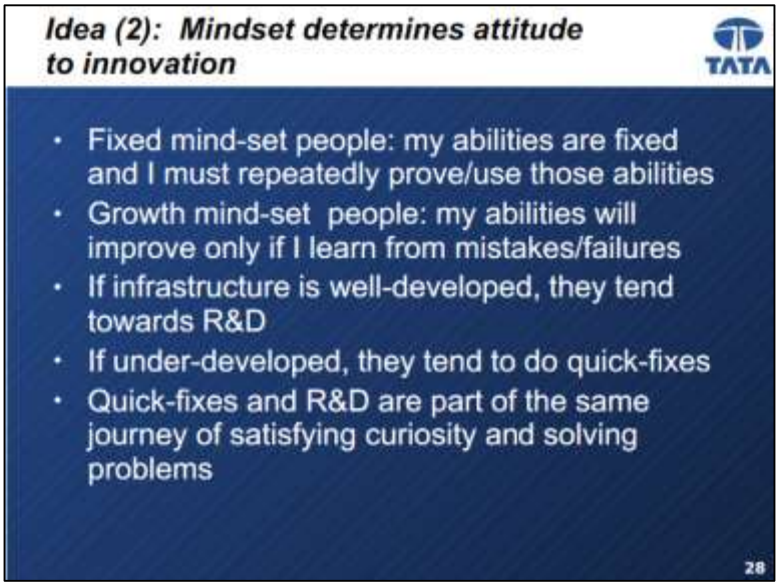


Fig. 4.3: Presentation on Innovation by R. Gopalakrishnan, Director Tata Sons [413]

4.2. Building Culture of Innovation

R Gopalakrishnan, Director, Tata Sons, while answering the question **"How do you foster an innovative approach across the entire Tata Group?"** stated that "The Tata Group is comprised of a large number of independent companies, and the way we operate is to provide good counsel from the center. It's like a parent and child relationship where we provide advice, but we don't dictate everything that each company does. We have created a body called the **Tata Group Innovation Forum**, which has representatives from many of the Tata Group companies. The idea behind it is to share experiences and knowledge across the Group and learn from each other. It is not prescriptive, but it is **encouraging and nurturing**." [412]

R Gopalakrishnan stated that "A critical point here is that the **cultural environment is more important than processes**. For innovation to happen and for it to flourish, you have to create an environment where people feel natural about what they are doing… For ties that endure, you need look no further than the Tata group. The Taj Mahal hotel in Bombay was the first building in the city to have electricity, ceiling fans and much else. Tata Steel was the first company in India to raise money from the public (nobody up to that point had envisioned Indians having money to invest in private equity). **The structure of the Tata group, the entire edifice, is a work of innovation**… Tata group has an innovation forum and its mandate is not to tell people how to innovate but to restore the natural order that generates outstanding innovations. We have a number of senior colleagues contributing to this endeavor, we have workshops and international experts and our own people going to different places in the world and seeing for themselves what is happening there on the innovation front. We have research publications and other material to further the learning, we have reward and recognition initiatives, and we have what we call the **Tata Innometer, which is a rating yardstick for innovativeness**… On April 26, every year we hand out innovation prizes to our most innovative people and companies. Here we have a category called **'dare to try'**, which **honors brave and original innovation efforts that have not been successful**." [415]

Woodman, Sawyer, and Griffin (1993) have defined organizational creativity as "the creation of a valuable, useful new product, service, idea, procedure or process by **individuals working together** in a complex social system". [1]

In order to become part of the organization, innovation needs to properly embedded and embodied in the organization, and as a long term plan not just a passing fad. Trying to change organizational culture can be messy and ineffective, as a large part of it is about changing attitudes and values, so focusing on some of the practical aspects can help to find a way forward. [26]

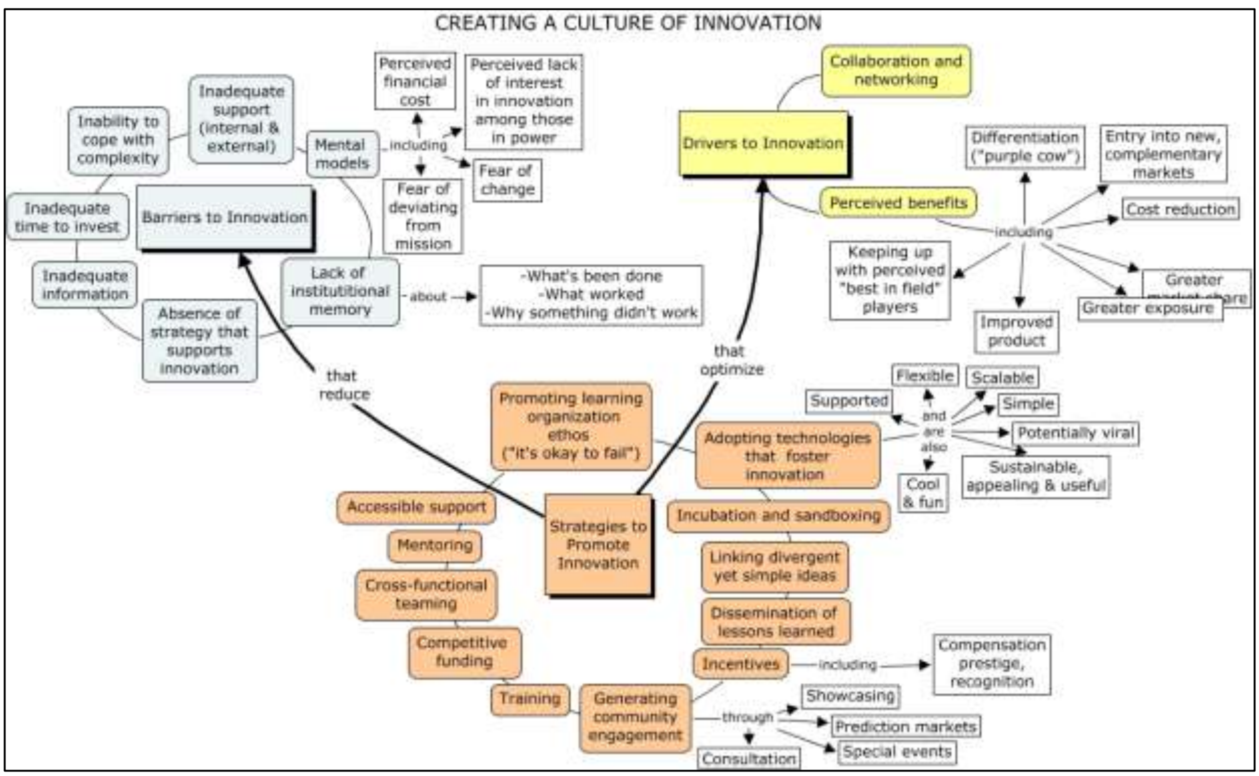


Fig. 4.4: Creating Culture of Innovation [262]

Fig. 4.5: Infographic: Build a Culture of Innovation [320]

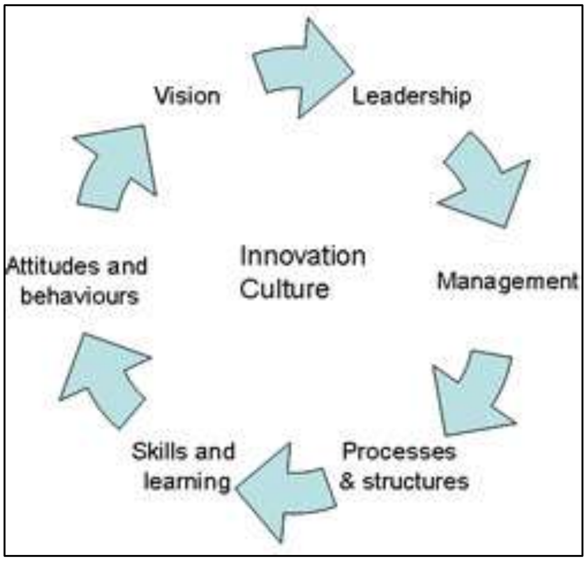


Fig. 4.6: Changing Organizational Innovation Culture [26]

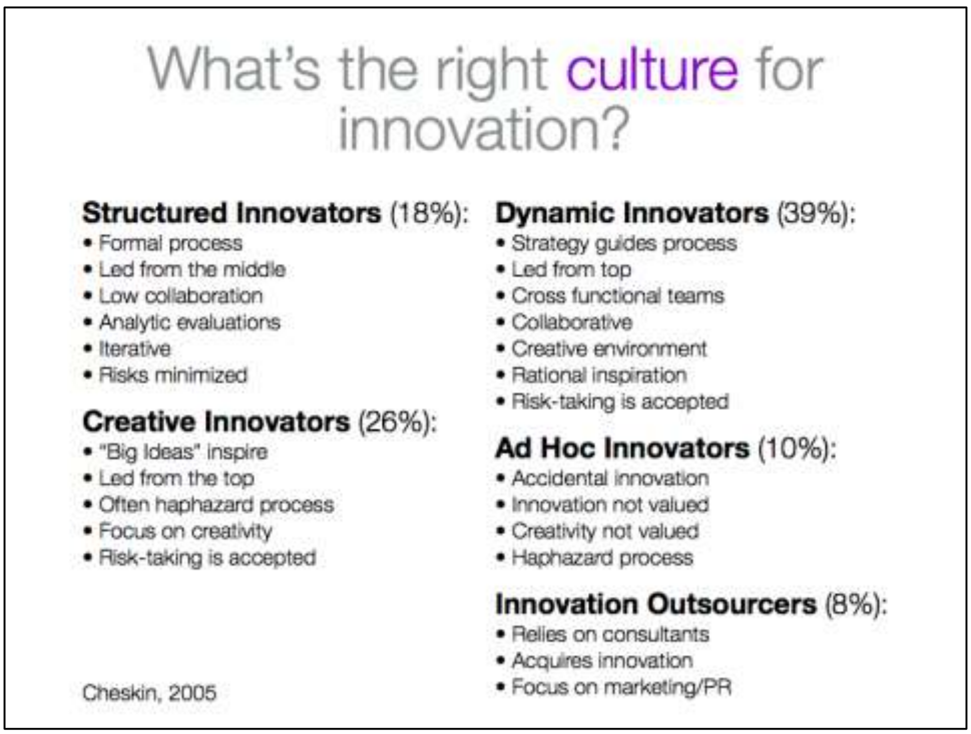


Fig. 4.7: Opinion (in percentage) about "What's the right culture for Innovation?" [317]

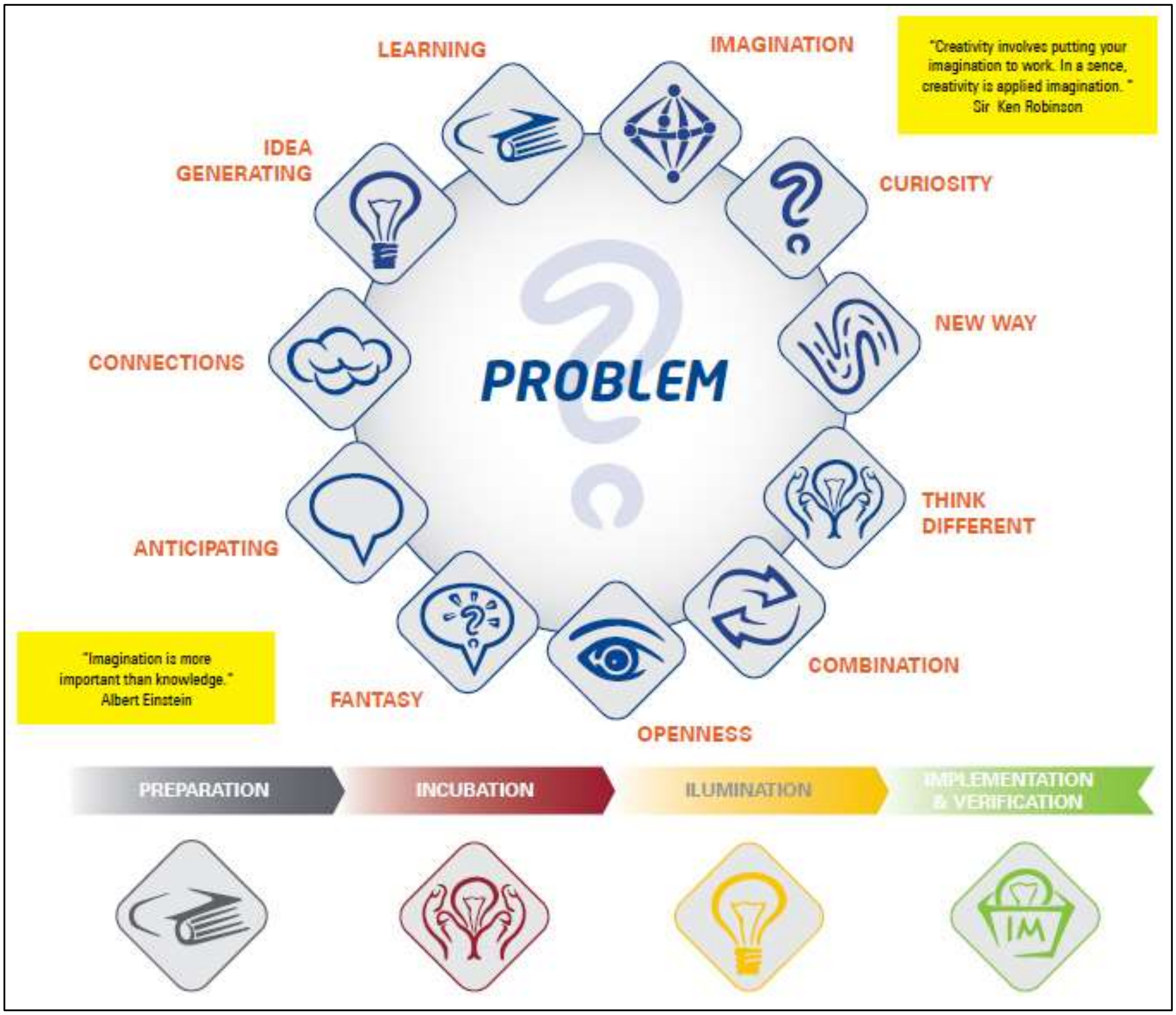


Fig. 4.8: KPMG Report: What helps Innovation to grow? [14]

Innovation is really a **mindset** – a set of habits of innovative people in innovative organizations…**Lack of ideas is never the problem**. Most of the winning ideas already live within your teams, partners, customers / users and networks. **The trick is to harness them within impactful and / or profitable innovation**. Mavericks within the team (and outside the organization) have more ideas and passion than most. But often they are sidetracked, ostracized or ignored. **Clustered** around them are often the other kinds of people needed to generate successful innovation – commercializes and those great at implementation. Centralized R&D / innovation prevents distributed innovators from prototyping, testing and iterating at the rapid pace they can work at when not managed centrally. Give natural innovators permission – and space / time / budget / credibility – to turn their ideas into innovations. Research also shows that diverse teams are often better than crack teams at solving complex problems so ensure that the team is made up of people that don't have the same perspectives. Encourage team member to understand the vital importance of their own personal and professional networks in their innovation capacity – and give them time and space to nurture their strong and weak ties inside and out. [295]

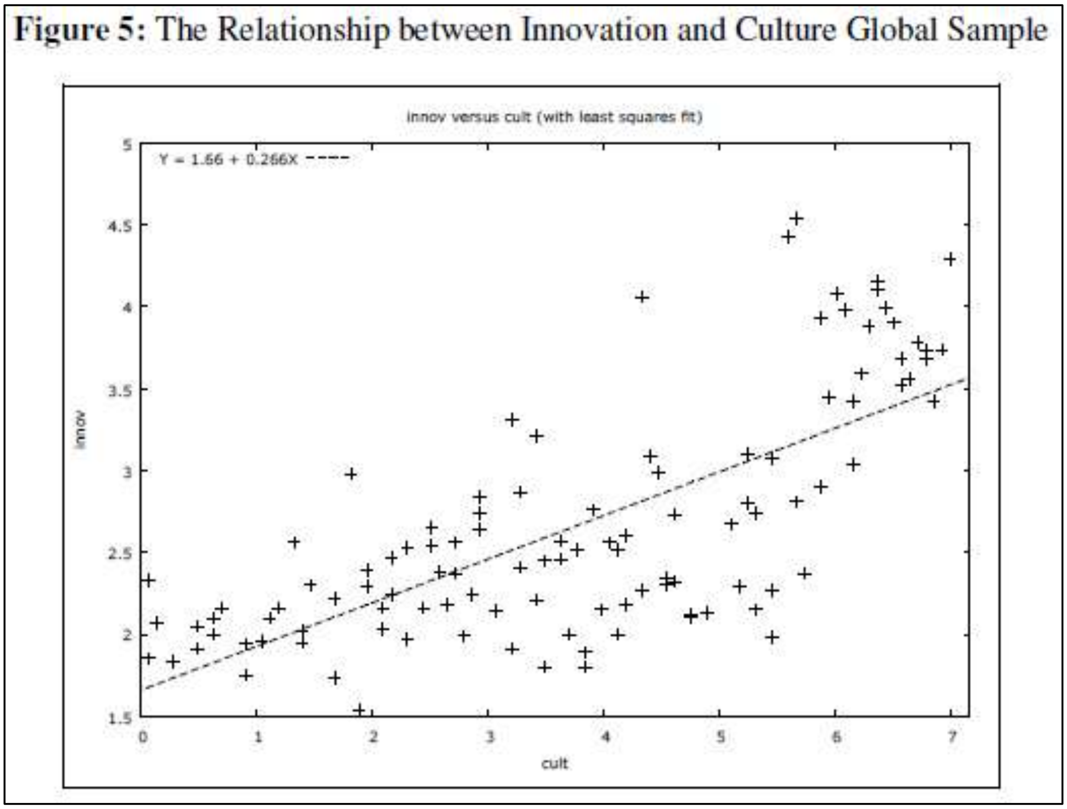


Fig. 4.9: Regression Analysis of Global Innovation Index data: Innovation and culture [254]

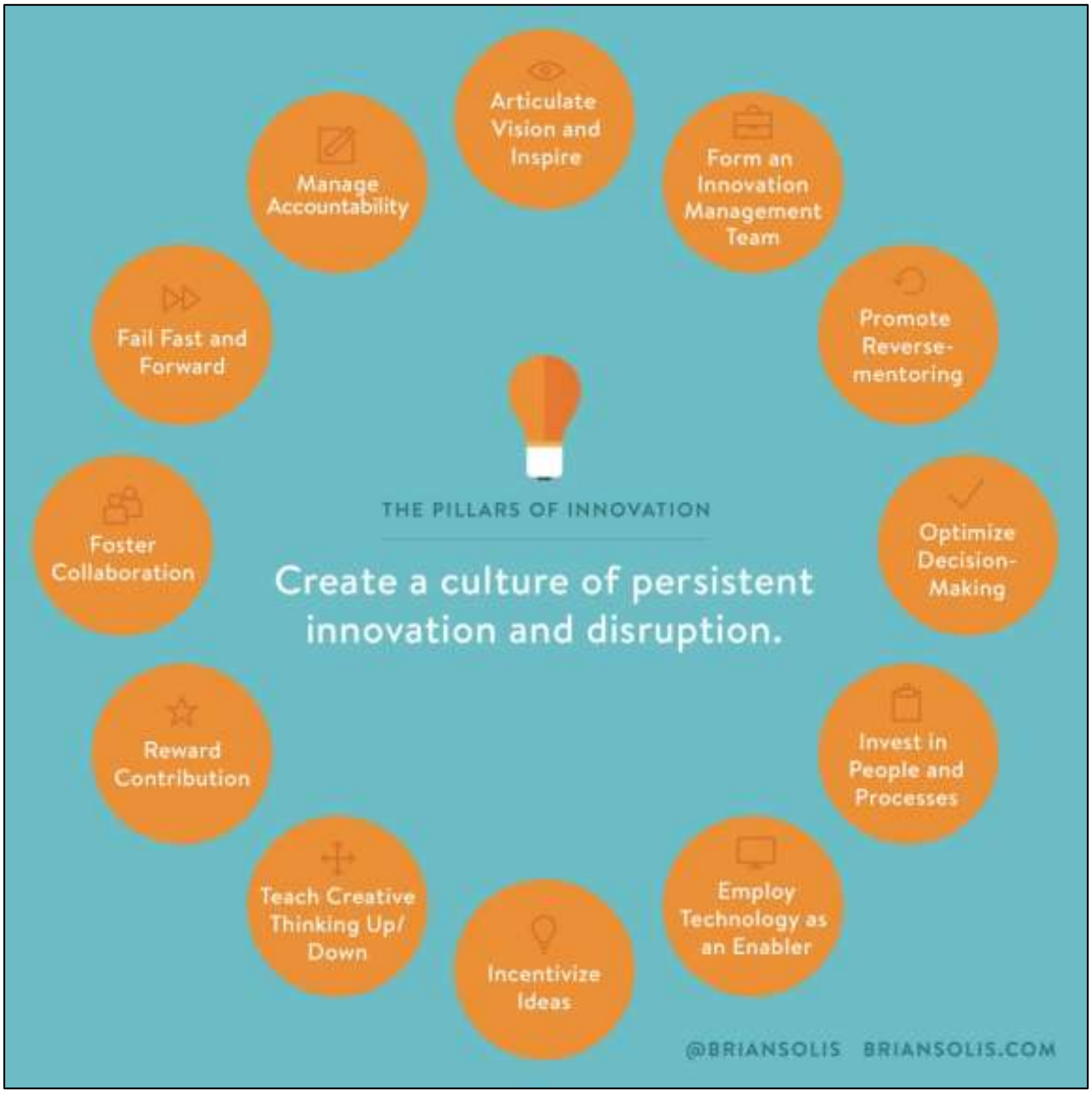


Fig. 4.10: The 12 Pillars of Innovation [48]

The basic principle for creating innovation in any organization are as follows. These seven dimensions of culture provide leaders with a lens that can help them take steps to enhance the conditions for innovation.

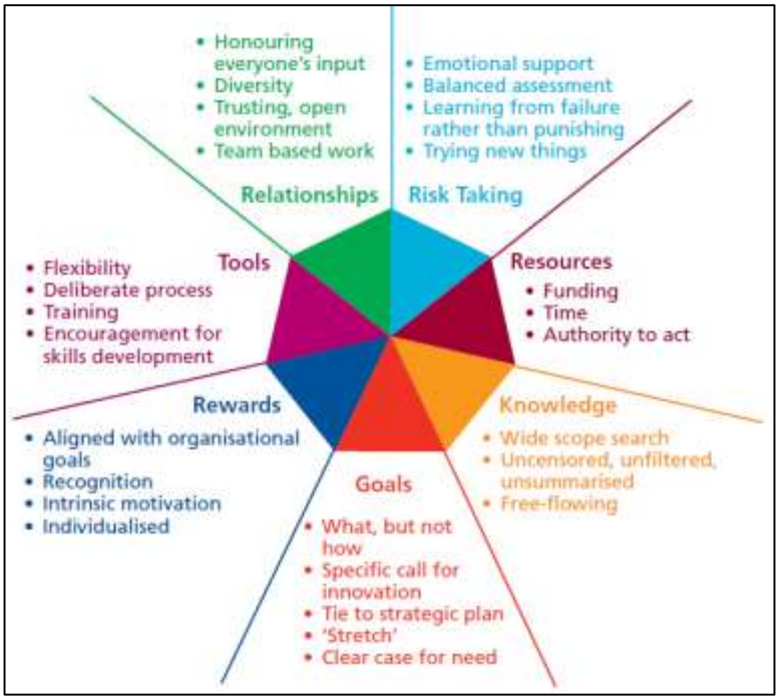


Fig. 4.11: Seven dimensions of culture for innovation [52]

4.3. Must Have Patience

The first thing to know about building a culture on innovation is that you will need to have patience. It takes time to change an organization's culture. This is one of those long-term investments; it usually takes six months to a year at a minimum before a team is equipped to implement the kind of change you are trying to make. [13]

Let's consider the example of one of the top most innovative company of the world "3M" (quoted in the article published at Harvard Business Review). "Richard Drew is just such an engineer. Running some Wetordry sandpaper tests at an auto-body shop to improve paint removal, he noticed that the painter was not able to mask one section of a two-tone car while painting the other. The tapes available at the time, back in the 1920s, either left a residue or reacted with the paint. Drew assured the painter that 3M could solve the problem and worked on it for two years, eventually receiving a memo from senior management instructing him to get back to work on the waterproof Wetordry sandpaper. Drew did, but he continued working on the tape project on his own time. The result: Scotch tape."… Acceptance of the need for 'stumbling in motion' as innovative ideas evolve and take shape. Breakthroughs like Post-it's and 'Scotchgard' were not overnight successes but took 2-3 years to 'cook' before they emerged as viable prospects to put into the formal system. [603] [607]

> One example of getting it right is the story of David Packard and HP's decision to jump into the computer market. At the time, the industry was dominated by IBM, DEC and others. HP managers made their case that HP should enter the market based on the company's expertise and capabilities. David wasn't convinced but made the decision to follow the expertise, commitment and passion of his executives. When the decision was made, David made it clear to everyone inside HP that this was a total commitment on the part of the company. The timeline he set out? To be the #1 computer manufacturer in the world in 25 years. How long did it take? HP became the #1 computer manufacturer in 23 years. [671]

Innovation takes time. More time than is expected. The organization must take the long view on innovation and avoid the temptation and resist the pressure for short-term adjustments. [671]

4.4. Change Management: A Challenging Task

Furthermore, it's really based on personal relationships, one-to-one relationships where you're talking with this individual and that individual over time in order to shift their minds in a new direction. It's like that with any kind of **change management** but especially when you're trying to build a new culture. This is about changing the business, looking to new organizational models, new ways of working, new processes, new tools, and new behaviors that you're trying to build into a team. [13]

Innovative leaders constantly evangelize the need for change. They replace the comfort of complacency with the hunger of ambition. 'We are doing well but we cannot rest on our laurels – we need to do even better. 'They explain that while trying new ventures is risky, standing still is riskier. They must paint a picture that shows an appealing future that is worth taking risks to achieve. The prospect involves perils and opportunities. The only way we can get there is by embracing change. [639]

4.5. Need Lots of Extra Efforts

That takes a lot of effort and that effort has to come in addition to the ongoing work of running the business. There really has to be a strong commitment from the people involved to put that extra effort in. [13]

4.6. Bureaucracy Kills Innovation

A creative individual enters the organization, but, through bureaucratic policies and procedures, the individual is made to conform. Creativity then dies. Organizations are often more geared towards assuring that all individuals function in the same manner and obey the rules, rather than in fostering creativity. The more rules and layers of bureaucracy that exist, the less likely it is that an organization will be innovative. [1]

A corollary to regulation and standardization is micromanagement. If an organization wants individuals to take risks but checks on them every day, or constantly evaluates them, then the conditions for **creativity will be nil**. Evaluation is, of course, important in any organization, but a constant system of oversight **lessens creativity**. Evaluation should **enhance performance, rather than monitor individuals for infractions or flaws**. A different sort of culture exists when **evaluation is geared toward improvement rather than penalization**. Individuals need a climate within the organization that **rewards experimentation**. If supervisors are constantly checking up on individuals, then their behavior is antithetical to a culture that rewards high performance. [1]

4.7. Innovative Companies Provide Forums for Employees to Pursue Opportunities

3M Corporation was awarded the US government's highest award for innovation, the National Medal of Technology. 3M has consistently been highly ranked, often in the top 20, in Fortune magazine's annual survey of "America's Most Admired Corporations." [603]

One of 3M's strengths is how it treats promising employees: give them opportunities, support them, and watch them learn and thrive. 3M provides a rich variety of centers and forums to create a pool of practical ideas that are then nurtured into opportunities and provided the necessary resources for success. Scientists go out into the field to observe customers to understand their pain points. Customers also visit Innovation Centers set up specifically for the purpose of exploring possibilities, solving problems, and generating product ideas. Scientists share knowledge and build relationships at the Technical Council, which meets periodically to discuss progress on technology projects, and the Technical Forum, an internal professional society where 3M scientists present papers— just two of 3M's fruitful forums. [603]

In a Harvard Business Review interview, Katsuaki Watanabe of Toyota said, "There is no genius in our company. We just do whatever we believe is right, trying every day to improve every little bit and piece. But when 70 years of very small improvements accumulate, they become a revolution." Over a 35-year period, Toyota's innovation culture increased the number of annual **suggestions per employee 480-fold** from 0.1 to 48. [610]

> Arthur Fry, a 3M employee, attended a Technical Council where Spencer Silver spoke about trying to develop a super-strong adhesive for use in building planes; instead, Silver accidentally created a weak adhesive that was a "solution without a problem." Fry, who sang in a church choir, had the niggling problem of losing the bookmark in his hymnbook. Fry noticed two important features of Silver's adhesive that made it suitable for bookmarks: the note was reusable, and it peeled away without leaving any residue. Fry applied for and received funding to develop a product based on Silver's accidental discovery. Thus was born the Post-it note. [603]

4.8. 'Resource' of Authority and Autonomy

The Resources dimension considers the broadest sense of the word. The climate for innovation is enhanced if people know that they have the 'resource' of authority and autonomy to act on innovative ideas. While innovative ideas do not necessarily need a lot of money or time to develop, staff can become demoralized if these traditional resources are not available and can feel that there is no point in putting forward a new idea. The presence of concrete resources signal that the organization is taking innovation seriously. [52]

People need autonomy. Do not create environments where people work in routine fashion. Create a culture where people are encouraged to control the means to reach an agreed upon goal. [1]

We all want control over our own environments. According to a 2008 study by Harvard University, there is a direct correlation between people who have the ability to call their own shots, and the value of their creative output. An employee who has to run every tiny detail by her boss for approval will quickly become numb to the creative process. The act of creativity is one of self-expression. Imagine a typical manager hovering over Picasso, barking orders, tapping his watch, questioning the return on investment, and demanding a full report "for the file" on why he chose a certain brushstroke technique. Picasso's creativity would shrivel. Granting autonomy also involves extending trust. By definition, your team may make decisions you would have made differently. The key is to provide a clear message of what results you are looking for or what problem you want the team to solve. From there, you need to extend trust and let them do their best work. Let them know you are behind them and value their judgment and creativity. If you show your belief in them, you will likely enjoy both the results you were seeking as well as a highly motivated and more confident team. [12]

The Tips for improving the resources dimension:

- **Reinforce the expectation that individuals and teams should feel they have authority to act on innovative ideas and seek to understand why they might feel they do not.** Do you know the reasons that staff might not feel able to act on new ideas? Many leaders don't, nor do they know the process that staff have to go through in order to gain permission to try something new. Do a 'spot check' during individual meetings or walk around by asking staff to tell you about ideas they have where they feel they need more permission to act. Be clear that you are very open to feedback. Be careful to provide emotional support and show genuine appreciation of their efforts and any difficulties they face. Be prepared to do something and communicate back to staff to raise their feeling of empowerment.
- **Turn strategically important innovation efforts into formal organizational projects with allocated resources.** The most obvious way to provide resources for innovation is simply to focus innovative thinking on areas where resources already exist. For example, if you already have people who are focusing on safety, challenge them to massively overachieve their own aspirations by thinking differently about this area.
- **Link innovation efforts to waste-reduction techniques that free up resources.** In a context of limited resources, it may be necessary to create head room for innovation by first embarking on productivity improvement and then allocating some of the savings to support innovative new ideas. In doing this, remember that it is important to acknowledge the contributions of staff in both the waste-reduction efforts and the innovation efforts.

- **Seek resources from non-traditional channels.** 'Think outside the box' a bit and you may find that there are more resources for innovation that you could access. [52]

4.9. Broad-based Knowledge

Broad-based **Knowledge** is the fuel for innovation. We create better conditions for innovation when information, both from within and outside the organization or system, is widely gathered, easily accessible, rapidly transmitted, and honestly communicated. Since we cannot know in advance what knowledge might stimulate an innovative idea, censoring, filtering or over-summarizing information detracts from this dimension. [52]

The Tips for improving the knowledge dimension
- Start a 'not invented here' programme where leaders, managers and staff are supported to seek out knowledge and ideas from outside that can be adapted to address key organizational challenges. For example, "This month, we are seeking ideas that we could adapt from elsewhere that will allow service users to gain greater access to services out of normal hours".
- Encourage staff to look for and share new ideas from other organizations, internal departments, or partners along pathways.
- Regularly share and celebrate innovations that are already happening in your organization or system.
- Share board information more widely and use knowledge from the workforce to support the board. [52]

4.10. Goals: What but Not How

Organizational and system leaders – whether team leads, managers, directors, executives, or commissioners – signal that innovation is highly desirable by setting aspirational **Goals** in specific areas and challenging others to find ways to realize the vision. Linking these to strategic priorities and being able to articulate a clear, multi-faceted case of need, further signals the importance of the call for innovation. However there is a caution. Innovative thinking is stifled when leaders go beyond statements of what needs to be achieved and also become prescriptive as to how it must be achieved. [52]

If we are to enable individuals to think creatively, then the goals of the organization cannot change from day to day, leader to leader. When a university vice chancellor or rector says that community involvement is important, and then five years later a new president says that actually research is paramount, confusion is created. When a dean or department chair says that teaching matters, but the provost says research matters, then a culture exists where individuals are unable to control the processes because the goals constantly shift. [1]

The Tips for improving the goals dimension:

- Identify and publicize widely the strategic issues where there is a clear case for the need for innovation and where an extension of the current way of working is clearly inadequate to meet the need. The key in articulating targets that stimulate innovation is to stick strictly to defining the 'what' and the 'why', but steadfastly avoid specifying the 'how'.
- Set out organization or system-wide challenge topics that call for innovative ideas in specific areas of need. This straightforward approach builds on the previous tip but goes a step further to create an '**innovation focus list'**. In the spirit of focusing, this list should be specific as to topics and no more than five to seven items.
- Articulate stretch goals in the language of **"how might we…?"** In many organizations, the word 'target' or 'goal' implies that there will be negative consequences associated with not meeting it, even if one falls short by only a small amount. The natural reaction is to want to avoid setting oneself up for negative consequences. Often, more thinking energy is devoted to arguing against the specific target than is given to coming up with innovative ideas. A simple way to avoid this is to state innovation goals and targets in the form of a question that begins: "How might we…?". This invites enquiry and creativity, rather than resistance and debate.
- Consider goals, contracts, annual appraisals, personal development plans, or job descriptions that require people to try out a number of innovative ideas annually and report back on what they have learned.
- Test for alignment of organizational or system-level goals for innovation by **asking staff where they think innovation is most needed**. The objective is to see whether you are communicating clearly enough to raise people's awareness of the need for innovation so that they are constantly on the lookout for innovative ideas. If they cite back to you the areas where you have set goals for innovation, then you have evidence of good communication. Otherwise, you are not fully capitalizing on the power of goals to create a culture for innovation. [52]

When you talk about Apple, you can never avoid mentioning Steve Jobs. To do so would be to underestimate his importance to the attitude of the company, and ultimately the brand. So what role did he play in the iPod? After developing a top-notch team, Jobs gave them ambitious and clear visions. He charged the team with creating a product that would **put 1,000 songs in their pocket**; **software so easy that their mothers could use it**; and a **complete product offering that would be in retail outlets in eight months**.

What is so exquisite about these objectives is that they are **simple, clear and precise**, yet broad enough so that the team could get to work without feeling constrained by the way the vision was presented — the team could be totally focused and liberated at the same time! Innovative leaders must provide a clear briefing that organizes a team but which, at the same time, **doesn't restrict their talent capabilities**. [624]

4.11. Appropriate Tools for Innovation

In high-performing organizations, **innovation is the product of the deliberate use of practical Tools**. Imagining that innovation will happen on its own if we just have the right culture would be as naive and irresponsible as imagining that financial controls would naturally emerge without some deliberate structures. While everyone is capable of innovative thinking, most of us have been socialized to be more conservative in our thinking in the work environment **Leaders, therefore, need to consider how they build capability and capacity in deliberate methods for creative thinking**. [52]

The Tips for improving the tools dimension:

- Develop a cadre of people who can facilitate creative thinking and innovation processes. Creative thinking is something that everyone can do. Providing training and facilitation resources to build the capability of staff sends a visible message that innovative ideas are desirable. Consider it a natural extension of the improvement teams, advisors, and toolkits used by many organizations.
- Require innovators seeking resources to explore how innovative their idea really is and how they might make it even more innovative. Consider each and every idea for change that comes to your attention as a 'teachable moment' that offers you the opportunity to further develop the culture for innovation. If someone is seeking resources, even if it is only the resource of your authority to proceed, encourage them to also stretch their thinking further.
- Plan to introduce new tools or methods for innovation periodically. Spread their use widely in simple ways that help everyone see how they might use them, and publicize their many applications. If you are already using a few tools for deliberate creative thinking and innovation, or after you have implemented some of the tips above, plan to keep the focus on innovation fresh by injecting new things into the mix. This continually communicates the value you place on new thinking. Keep it simple and seek to introduce new tools and methods as part of daily work rather than always imagining that some sort of formal training is needed. [52]

4.12. Relationship Dimension

The Relationships dimension refers to the patterns of interaction between people in the organization or system. **Innovative ideas are rarely the product of a lone genius.** Even when they might appear to be, delving further into the story nearly always reveals that the idea was formed over time and through multiple interactions with others that fuelled the process. Therefore, environments where staff are routinely exposed to a wide range of different thinking, from a wide-range of people, with a wide range of backgrounds and points of view, provide rich soil for the growth of innovation. Of course, it is more than just exposure; one can be 'exposed' to a diverse group of people while riding on a train and not be stimulated to innovate. There must be a sense of common purpose; of being in a 'team' with others. This team environment must also enable those with different thinking to trust that their input will be honored and explored, rather than immediately argued against. [52]

The Tips for improving the relationships dimension:

- Create many opportunities for diverse individuals to work together and learn more about each other's ways of thinking. One of the simplest things that leaders can do to build relationships that favor innovation is to create more and more opportunities for multi-disciplinary interaction. You may get a completely different set of ideas that would not have emerged from any of the individual staff groups.

- Use one of the many personal style instruments as a way to get people to honor differences between themselves and others as refreshing and useful. There are literally dozens of simple style instruments that provide a structure and a language for beginning the exploration of one another's difference in a more objective way. The knowledge and learning potential of this type of exercise is invaluable and creates great team-building discussions. This process gives everyone a better appreciation for differences within teams, avoiding potential frustration and enabling more understanding going forward.
- Start an ongoing dialogue about what 'teamwork' or 'a trusting and open environment' means and what it really looks like. Another sort of diversity in teams is a difference in what are called 'mental models': the images that humans naturally create in their mind's eye when they hear a word. If individuals have different mental models, it can lead to conflict and frustration when they try to work together.
- Bring in non-traditional team members precisely for their potentially very different points of view. By 'non-traditional' we mean, for example, service users, careers, people in the community, people from the private sector, someone who knows little about how you currently do things, university students, designers, engineers, family members, and so on. Be sure to prepare your staff for how to receive these new team members. If the fresh perspective is greeted with genuine openness, curiosity, and a desire to see where it takes us, new approaches to issues are possible.
- Increase the use of job shadowing, short-term work rotations and longer-term secondments to increase individuals' awareness and valuing of different ways of thinking and working. These structures from workforce development enable one to gain a more diverse perspective by "**walking a mile in someone else's shoes**". For example, having doctors spending time shadowing a nurse, or the Finance Director shadowing a porter might provide new insights into how, together, they might do things differently to benefit patients and carers, as well as each other. [52]

4.13. Fuel Passion, Articulate Vision, Cultivate Engagement & Enthusiasm, Inspire & Enable Motivation

Organizations cannot move in a new direction unless that vision is conceived, articulated and motivating. People, customers and employees, they need something to believe in…something to follow. That starts with communicating where we want to go and why it's important and different. [48]

Innovation won't just happen by itself, it needs stimulating, growing, supporting and encouraging. So it's easy to see how it becomes entangled in organizational culture. Is it enough to have a vision that states the organization is innovative? What happens when your organizational processes and structures don't for example support risk taking? What happens is that the espoused values of the organization become undermined by the "way we do things around here" i.e. the culture. [26]

"The most powerful weapon on earth is the human soul on fire," says Ferdinand Foch, the early 20th century French military theorist. Passion is the first—and most essential—ingredient for building a creative culture. Every great invention, every medical breakthrough, and every advance of humankind began with passion. A passion for change—for making the world a better place. A passion to contribute—to make a difference. A passion to discover something new. With a team full of passion, you can accomplish just about anything. Without it, your employees become mere clock-punching automatons. One key is to realize that passion alone isn't quite enough: You must also focus that passion into a sense of purpose. Steve Jobs wanted to "put a ding in the universe." Whole Foods Market was founded with the goal of becoming the world's leading natural and organic foods supermarket retailer. Pixar wanted to reinvent the animated film industry. Pfizer is about saving lives. Your specific purpose must be your own, but the bigger and more important your purpose is, the more passion it has the potential to create within your team. [12]

In an environment where fiscal resources are in short supply, symbolic resources matter. An innovative organization needs to create a culture that applauds experimentation and risk-taking. Hence, an organization's leaders need to give verbal support to people who are innovators. Organizations convey the kind of culture they want by what they communicate to one another. [1]

> Apple Story: Even with a reputation for getting involved in projects, Steve Jobs actually didn't interfere all that much with the iPod project. He was both smart enough to compose a highly skilled team and then to let their skills shine. Yet, along the way, Jobs acted as both a **policeman and cheerleader** for the project. He imposed an attitude that let the team members know that **Apple's win would also be their personally**. And, by cheerleading, he was also able to police the parameters of the project, ensuring the team stuck to his briefing goals. [624]

4.14. Promote Reverse Mentoring

There's a "disconnect" today between older generations and the Millennials pervading the workforce. Older managers feel that younger generations have unrealistic expectations and they haven't paid the same dues they did to earn success. At the same time, younger generations live life differently and can't understand why others just don't take the time to better understand their "day in the life." Innovative companies such as GE promote reverse-mentoring to foster understanding, create mutual empathy and promote collaboration between disparate generations of team members. [48]

4.15. Optimize Decision-Making

Decision-making is the chokehold of corporate creativity. "Evaluate how to optimize decisions and also introduce paths for ideas to earn consideration, development and expansion." This may start with the innovation management team, but ultimately, decision-making around ideas and creativity will benefit the entire enterprise and thus requires top-down implementation. Empowerment is key here. [48]

4.16. Invest in People and Processes

People are a core asset to your organization. At the same time, without the right training, processes, systems, or management, people can also become the hindrance. Everyday businesses practices, how employees are trained and reviewed, and also the time they spend on day-to-day projects versus thinking about or pursuing new ideas are the keystone to a stronger creative and collaborative foundation. We are all students now and learning is how we stay competitive. [48]

> So the answer to why **Samsung is so innovative** – with at least two major product announcements this month – is that it is **heavily invested in its people**, it goes in **search of special talent** wherever it can find it, but specifically made astute moves into Russia early on; it targets its innovations towards specific competitors and patents that it wants to overhaul (as Apple did under Jobs); and it has an **innovation culture based on extensive training, repeatable methodology and creative elite formation**, backed by the highest levels of management. [660]

> Joe Adachi President and CEO of Canon USA stated that "Throughout the past 10 years, **Canon** has spent an average of just over eight percent of net sales on R&D, and the Company has been among the **top four leading patent-holding companies in the world** for the past 15 years. During the height of the recession in 2008, **Canon invested 9.1 percent into R&D**. A dedication to research and development helps companies maximize efficiency, lower environmental impacts and increase precision." [684]

4.17. Employ Technology as an Enabler

With the rise of social, mobile, real-time, cloud and every new technology trend, organizations are often faced with a confusing and overwhelming set of options to consider for implementation. Some though get caught in the technology trap by fooling themselves that they would become irrelevant without the adoption of everything in some way. This is only partly true. Technology is often the right thing to "do" but the "why" it's introduced is often the missing ingredient to success. Technology alone though isn't the answer. Technology is merely a means to facilitate connections, provide direction, learn, collaborate, and remind people why they (and you) matter… their way. It's tempered with empathy, purpose and aspiration, to do things better than how we did them yesterday. Technology must be an enabler of the greater vision, purpose and bottom line business objectives. [48]

4.18. Use New Technology

German scribes mocked the early printing presses as unreliable "contraptions" that would never replace hand-written books. Forward-looking organizations should identify and embrace new technologies that can increase the flow of input from external sources and simplify operational work such as the grant making process. [36]

4.19. Reward Risk, Celebrate & Incentivize Ideas

Encourage courage is something that most risk-averse organizations chastise or discourage. Ideas are precious and the ecosystem where they are introduced can be fragile. Make it fun or lucrative to introduce them and also spotlight them as part of everyday business practices. The most innovative businesses take ideation further by instilling it in everyday job responsibilities and performance management (up and down). Everyone is expected to contribute and managers are expected to cultivate and consider ideas. At the same time, innovative companies find a way to reward risk. This is key in organizations where corporate "whack-a-mole" prevents people from thinking outside of the box for fear of punishment or ridicule. [48]

Social norms in any **culture are established by what is celebrated and what is punished**. Consider more narrowly how they function within an institution. Nearly every business's mission statement includes words about "innovation," yet risk-taking and creativity are often punished instead of rewarded. Rewards come in many forms, and often the **monetary ones are the least important**. Celebrating creativity is not only about handing out bonus checks for great ideas—although that is a good start. It should also be celebrated with praise (both public and private), career opportunities, and perks. In short, if you want your team to be creative, you need to establish an environment that rewards them for doing so. [12]

Risk Taking is about establishing an organizational climate where people feel free to try out new ideas. While it is obviously important to avoid taking inappropriate risk, a healthy organizational culture seeks a balanced assessment that avoids prematurely rejecting ideas due to over-estimation of risk. It also requires leaders who show they are quick to provide emotional support to those willing to try something new, regardless of whether the idea is eventually judged a success or 'failure'. Leaders in innovative organizations demonstrate that they are more interested in learning from failure than in punishing it. [52]

The Tips for improving the risk taking dimension:

- Share widely how the organization or system has taken reasonable risks on innovative ideas in the past**.** If staff don't see leaders actively supporting reasonable risk taking, they may get the impression that it isn't supported. The solutions are simple. For example:
    - Be transparent about how risk is assessed in the organization. Consider how you can keep staff informed about this
    - Publicize new ideas that are being tested, outline the anticipated benefits and risks, and describe the roles of senior leaders in supporting these
    - Talk about hard decisions made at board level to support innovative pilots and new ways of working
    - Be seen speaking openly about innovative ideas before you are sure that they work.

- Establish a process to **publicize and learn from ideas that 'fail'.** Make it routine and acceptable to talk about ideas that were tried but 'failed'. Work from the mindset that the only 'failure' is the failure to learn, and that not sharing and learning from things that don't go as planned is waste and lost productivity.
- Go out of your way to provide **emotional support for innovators.** Leaders who understand and recognize the potential in staff make it their business to know the individuals and teams who are doing innovative things and personally connect with them. Go out to the person's work area, or to the department or team, and take an interest. Show that you know what they are doing, ask what they are learning, and ask what you can do to help. Keep the lines of communication open through periodic walk around or telephone calls.
- Reverse a negative, worse-case scenario culture by establishing new conversation practices when innovative ideas are presented. When presented with a new idea, people can be quick to point out what might go wrong, ask for strong evidence to support the new idea, or note that it would not work under certain circumstances. Take the lead in reversing this behavior and mindset by acting differently and encouraging others to do the same. For example, when presented with new ideas:
    - Create a rule that the benefits of the idea are listed first before any discussion about what could go wrong
    - Recognize that the new idea may not work for every group or situation. However, ensure that any decision is made on the benefits for the majority rather than not using the idea because it does not benefit everyone in every situation. Design for 80% rather than 20% of your organization.
    - Ask for the evidence that supports the status quo approach. Ask that the new idea be judged fairly to the same standard of evidence that we allow for the status quo practice.
- Don't use humor to lighten the mood when discussing the risks associated with an innovative idea. It almost never works and often has the opposite effect.
- **Feed the rumor mill to positive effect.** As you try some of these tips realize that, your new behavior is likely to take others by surprise. Invariably, this will start a buzz around the organization. This will have a positive effect in terms of improving the conditions for innovation, for it has been said that the 'rumor mill' is often the most efficient internal communications vehicle in any organization. [52]

4.20. Reward Contribution

Make sure that the people involved in your innovation program are rewarded and recognized for the hard work they've put in— submitting the ideas they've generated, executing on those ideas and creating the proof of concept. Measurement of your innovation process is critical to understanding what you're producing and what business value results from the ideas generated. [13]

HR needs a seat in the Innovation Management Team. Contributions must be rewarded. Risk takers deserve recognition. You're asking people to do something beyond, in most cases, the reason why they're where they are today. Reward employees for their contributions and also spotlight those that contribute every step of the way. Share insights and best practices. Reward systems and responsibilities will need updating to accommodate new processes and barometers for success. [48]

Rewards for innovation are symbols and rituals whose main purpose is to recognize innovative behavior. They signal how much value is given, or not, to the efforts of individuals and teams who come up with new ways to help the organization or system achieve its strategic goals. Because it is all about encouraging more of this sort of behavior, the best recognition is that which appeals to people's intrinsic and individualized motivation. The most successful recognition schemes avoid a one-size-fits-all approach and are instead based on a deeper understanding of what makes people do what they do. For example, frequent personal expression of appreciation is **often more important to people than financial reward**. [52]

The Tips for improving the rewards dimension:

- Seek to understand and work with what intrinsically motivates innovators. You may need an array of ways to recognize accomplishments and a way to match these to an understanding of what is meaningful to each individual you wish to recognize. **The vast majority of people do not do what they do in order only to get more money**.
- Set up structures and processes to enable peer, patient and career recognition for innovation. **Don't think of rewards and recognition as only being top-down**, or something that comes only from 'an organization'. For many staff, being recognized by peers, patients and careers is very important and meaningful. Comments from peers and patients could be incorporated into an internal newsletter article, the local press, or an internal awards ceremony.
- **Reward and recognize 'failed' attempts** at innovation where you can celebrate learning. If individuals and teams who try a new idea that fails are shunned, even just a little or in seeming jest, they are less likely to try to innovate again. Whatever you decide to do for rewarding innovation in your team, or organization, make sure that you design something to also **recognize 'attempts with learning'**. When the culture is such that it seems just as easy to talk about these examples as it is to talk about successful innovations, you will have gone a long way towards creating the culture for innovation.
- **Grand prizes and competitions create a few winners, but also lots of losers. Instead seek to reward all legitimate innovations and attempts.** Establish reasonable, but explicit and transparent, criteria for what you want to call an 'innovation' or an 'attempt with learning' and then recognize as many or as few examples as meet the criteria. If there are 37 examples that meet the criteria, recognize them all equally. If there are only 2 that meet the criteria, recognize those and call for more like them. [52]

The examples of Incentives are:

- Vouchers – Restaurants
- Products
- Cash
- Gift Cards
- Dinner with CEO or other VPs
- Awards Dinner
- Wall of Fame
- Promotional Video
- Letter of acknowledgment

- Gifts - Memos on company intranet
- Spot prizes
- Extra vacation days
- Choosing projects to work on
- Gaining time off from regular projects to work on innovation
- Joining the implementation team
- Joining the innovation team
- Receiving company products at a discount

More details are available at website www.tlnt.com [618] [619]

At **Dow Chemicals**, risk-taking is not only accepted, it is encouraged, which helps the company to stay agile and innovative. [676]

- 3M Company. Their Innovator's Award recognizes effort rather than achievement [607]
- Tata Group's regional and global innovation contests, a rubric named "Dare to Try" provides rewards for failures that are informative. [617]
- At Google's lab X and at WPP's advertising firm Grey Group in New York, employees can be rewarded for brilliant failures that provide some sort of insight, even if they turn out not to work. [617]

4.21. Teach Creative Thinking & Doing, Mockup Crazy Ideas

Creative thinking is something that isn't relegated to just the chosen few. Everyone has the means within them to uncover a problem and solve it or see opportunities when others cannot or will not. Workshops, off-sites, events, they must inspire employees, executives and leaders alike. I refer to this approach as the dilemma's innovator. It's a combination of design thinking and problem solving that allows for people to not only address quandaries but also create or surface something new. This must be taught as the process for evaluating empathy and context is different than the traditional critical thinking approach many organizations promote today. Most importantly, time is needed to help people think differently. Whether its 5 hours, 10, or 20 hours a month, give employees time to learn something new or develop a concept outside of their day-to-day duties. [48]

Much of the thinking done in formal education emphasizes the skills of analysis--teaching students how to understand claims, follow or create a logical argument, figure out the answer, eliminate the incorrect paths and focus on the correct one. However, there is another kind of thinking, one that focuses on exploring ideas, generating possibilities, looking for many right answers rather than just one. Both of these kinds of thinking are vital to a successful working life, yet the latter one tends to be ignored until after college. [24]

Whirlpool, the world's largest appliance maker, was an engineering- and manufacturing-oriented company fixated on quality and cost. Its products were mostly commodities sold at large retailers, such as Sears and Best Buy. In 1999, the Michigan-based company embarked on a mission to be recognized as being an innovation leader as well. The company started by enlisting 75 employees from across the company to brainstorm about innovative products. The group came up with one hit product, but most ideas were viewed as too far-out or insignificant. Like many first-time innovators, people had a difficult time seeing how a more far-reaching idea could turn into an opportunity. That's when Whirlpool decided to try a different tack.

First, every salaried employee was enrolled in a business innovation course. Second, the company trained certain employees, called I-mentors, who were similar to the Six Sigma Black Belts who worked on quality in the company. The "I-mentors" still kept their regular jobs but brought to those roles special training on how to facilitate innovation projects and help people with their ideas. An intranet portal offered employees a common forum for learning principles of innovation, keeping abreast of recent research and tracking the progress of ideas toward realization. Innovation teams comprised of employees from all levels of the company screened and vetted new ideas.

Two years into the program, Whirlpool had 100 business ideas, 40 concepts in experimentation and 25 products and business ideas in the prototype stage. By early 2006, Whirlpool had hundreds of ideas in the pipeline, 60 in the prototype stage and 190 being scaled for the market. By 2007, new products stemming from the innovation areas contributed nearly $2.5 billion in worldwide revenue, and approximately **$4 billion of $19 billion in 2008 revenues**. In 2008, Whirlpool had 61,000 employees and nearly 1,100 volunteer I-mentors worldwide who helped facilitate innovation throughout the business. Executives at Whirlpool ascribe their success in part to the way this investment in innovation and training has changed the company's culture. [677]

4.22. Create the Conditions for Teamwork & Involved Everyone

A conundrum of academic environments is that **professors are often isolates and introverts**. Individuals tend to work alone. At the same time, the "academic community" exists as a composite group. If we wish to create an organization geared toward innovation, then we have to **pay careful attention to the kinds of communities we create**, insofar as 'group-think' works against innovation. As Scott Page (2007) has noted, "distributed problem solving can be thought of as a form of innovation. The opening up of innovation activities is sometimes called 'distributed co-creation'". The organization needs various intellectual foundations and approaches to work. Different expertise, different thinking styles, and different age levels enrich an innovative environment. We underestimate that a sense of a shared vision can be exciting, and that shared vision comes through a diversity of perspectives. As Page has noted in his important work on organizations, "diversity means differences in how people see, categorize, understand and go about improving the world”. From this perspective, the organization, on the one hand, needs to create the conditions for multiple perspectives and ideas to occur. On the other hand, the organization also needs to be able to orchestrate those perspectives into a cohesive unit. Some might liken this to an orchestra where individuals play different instruments. They have different tasks and interpretations, but ultimately they need to come together to create music. From an organizational perspective, if people do not coalesce around a vision, then a commitment to innovation will lessen. If we do not respect alternative styles or what a person brings to the team, then the organization ends up with an isolated culture where people go their own way. [1]

No central innovation function - everyone in the firm is responsible for making innovation happen. Google expects everyone in the company to innovate, even administrative and finance staff. The source of the innovation matters less than the innovation itself. [36]

Don't make innovation the responsibility of a few. Make innovation the responsibility of each and every employee with performance goals for each and every functional area. [334]

4.23. Maximize Diversity

Help people broaden their perspective by creating diverse teams and rotating employees into new projects -- especially ones they are fascinated by. [334]

Diversity in all its shapes, colors, and flavors helps build creative cultures. Diversity of people and thought; diversity of work experiences, religions, nationalities, hobbies, political beliefs, races, sexual preference, age, musical tastes, and even favorite sports teams. The magic really happens when diverse perspectives and experiences come together to form something entirely new. One person's experience working as a college intern on Wall Street may fuse with another person's experience growing up in a small village in Italy to generate a fresh idea that neither would have considered independently. This melting pot approach can drive some of the most creative cultures, thinking, and ultimately business results. [12]

> Ziba, a top innovation-consulting firm in Portland, maximizes the value of a diverse workforce. The company's 120 employees are from 18 different countries and speak 26 languages. According to Sohrab Vossoughi, the firm's founder and president, “genetic diversity breeds creativity, much like it does with biology.” The company also has an “Ambassador Program,” which allows employees to spend three months working in other disciplines, known as "tribes." During that time, the ambassador team member really participates as part of those teams. "This helps to create an understanding of another world," according to Vossoughi. That diversity of thought and perspective, in turn, can fuels creativity. It also translates to business results. Ziba is one of the most prolific and successful innovation firms in the world. [12]

> **Cisco**, which use an inclusion and diversity strategy to build upon the company's goals and strengths and support the overall strategy. The Chairman and CEO John Chambers says: "When we talk about diversity at Cisco…it's about inclusion – bringing together a diverse workforce with unique life experiences, cultures, talents and perspectives. We promote a creative, innovative and collaborative environment that helps drive our business strategy." [689]

According to recent research by Center for Talent Innovation (CTI), there is a significant link between diversity and innovation – if you understand how to unlock the potential. CTI is a New York based leading global talent think tank with members such as McKinsey & Company, Google, Hewlett-Packard and New York Times. With input from 1,800 survey respondents, 40 Fortune 500 case studies and 100 plus innovators, the CTI-research found that the existence of two-dimensional (2D) diversity in an organization could be a magical driver for serial innovation. [689]

Bill Gates, Microsoft stated that "The collaborative energy that is created when talented people from different backgrounds come together to focus on innovation has helped fuel Microsoft's success for more than 30 years. As we bring our innovations into more and more markets around the world, and as we strive to bridge the digital divide so that people at all levels of society can benefit from the opportunities of the global knowledge economy, we recognize that it's more important than ever to honor diversity, both inside Microsoft and in the communities where we live and work." [690]

4.24. Be Open, Have Wide Exposure, Foster Collaboration & Networking

Enterprise social networks, social media, collaboration tools, these are all designed to help people better work together. In many cases, businesses remove traditional barriers that separate work groups allowing for people who don't normally see or talk to one another have the chance to co-mingle. Google will often say that its MicroKitchens in every building allow for sparks of ingenuity that wouldn't have happened if two or more people weren't getting a snack at the same time. Give them reason to do so and expand engagement beyond traditional work groups. Bring people together who share common passions and interests and give them the space and the time to work together. [48]

That is exploring collaboration beyond borders. Connect the people from diverse range of backgrounds. Form the groups offline and online. [50]

Forget the normal boundaries and bring together talented people from a wide variety of fields and disciplines to work together and cross-fertilize. Look both inside and outside your existing organization for new types of innovation partnerships. Great ideas are rarely created by a solitary genius. More often, innovation comes from the right network of people and teams bringing disparate ideas together. The iconic image of innovation often portrays Thomas Edison as the sole inventor of the light bulb, but Edison was actually an astute knowledge broker who developed his famous Menlo Park lab to bring together thinkers and their inventions, out of which came the light bulb. Innovators often collaborate with those inside and outside their organizations to bridge across and recombine existing ideas into new ones. Collaboration nurtures emergence, which can often lead to unexpected opportunities. Networks are also critical to the diffusion and spread of innovation, as adoption often relies on the choices made by other actors within a system. Expectations that staff should work collaboratively inside the organization and/or externally must be clear, demonstrated actively, and reiterated continuously. The organizational structure, including the allocation of appropriate resources of time and other supports, are needed to bolster collaborative working relationships. And new tools for social network analysis now allow us to see and understand networks of relationships that were previously invisible to us. Building a full view of your network enables an organization to understand its human resources better and to accelerate the flow of information, ideas, and products in and out of your organization. [36]

One of the most important lessons executives have learned about innovation in the past few years is that companies **shouldn't go it alone**. Increasingly, companies are **drawing business partners and suppliers into innovation networks**. That brings more minds to bear and speeds up product development. Once seen as novel and risky, such external collaborations are now accepted as necessary and even routine ways of doing business. [666]

What really sets the iPod apart from all of the other mp3 players, however, is neither the hardware, the software, nor the design – although all are world-class. The iPod's real differentiator is the ease with which the customer can access, download, store and upload the music and podcasts. No one else can do this, and this "innovation" did not come from within Apple, but from an outsider – Tony Fadell – who was trying to do this on his own.

Apple found him – **think about how difficult that is, to find someone with a good idea outside of your firm** – and **hired him on an eight-week contract**! This was not about building a long-term employment relationship, nor about loyalty, but about accessing someone else's good idea. [624]

Sigvald Harryson identifies and illustrates the key mechanisms that these companies use to foster **product innovation**. His examples show how **Canon** and **Sony** use a combination of external and internal networking mechanisms to identify and acquire key technologies and related skills, gain market knowledge, improve the results of internal R&D efforts, and ensure the successful transfer of these results to efficient production processes.

He identifies four key mechanisms underlying successful product innovation at Canon and Sony: **strategic training and job rotation for engineers**, **application-driven R&D**, **direct transfer of development teams from R&D to production**, and **extensive networking with external centers of excellence and key suppliers**. At Canon, the initial training program for all researchers and engineers begins with three months of work on a production line. Sony's new researchers and development engineers spend one month in production. Both companies also give their new R&D professionals three months of training in sales and marketing. [683]

Boeing provides one of the best models. Its 787 Dreamliner, which is expected to roll out of the factory in July, is a technological marvel. Made of composites and other lightweight materials, it promises to use 20% less fuel than current jetliners and improve passenger comfort, including cabin air quality.

But Boeing couldn't have accomplished all of this on its own. Traditionally, the aerospace giant micromanaged design and production of a jet's components—a pricey approach that helped cause the budget of its previous plane, the 777, to **double in cost**, from $6 billion to $12 billion. This time, **Boeing realized that real technological innovation would only be possible at a reasonable cost if it shared the risk with partners**. Many of the details of the plane's design are being handled by suppliers in Japan, Italy, and the U.S. Tokyo-based Mitsubishi Motors Corp. is creating the wing, while Italy's Alenia Aeronautica is producing the rear fuselage and the horizontal stabilizer (the small wing on the plane's tail).

Such a massive change to its approach was hardly easy. "Were we comfortable looking for better ideas outside of the company? No," says Mike Bair, vice-president of the 787 program. "To a lot of people inside the company, it was perceived as a loss of control."

One of the keys to pulling this off was the company's **careful attention to managing culture change**. To help reassure Boeing managers of their suppliers' progress, the company formed a global "**partner council**," a team of senior leaders from each company who met face-to-face every six weeks to help resolve new problems. Once production of the plane got going, Boeing sent teams of engineers from one supplier to the next, acting as roving in-house consultants who share best practices. The collaborative bet appears to be paying off. Development time has shrunk by about a year. That's **helping to keep costs down**, both for Boeing, which will spend an estimated **$6 billion to $8 billion** on the plane, and its customers, which will pay about **$130 million apiece**. That's around the same price as a 1980s-era airplane. Carriers are lining up for the new jets; in April, Boeing topped 500 orders in record time. [666]

4.25. Promoting Regional Collaboration

The Fund for Our Economic Future is re-thinking the geographical focus of philanthropic collaboration by bringing together more than 100 philanthropic organizations impacting 16 counties to advance an agenda of economic transformation that will strengthen the region of Northeastern Ohio through grant-making, research and civic engagement. The impact of the regional collaboration has already had positive repercussions in the public and financial sectors, resulting in collaboration by the region’s mayors to jointly explore tax revenue sharing, in various Chamber Heads meeting on various initiatives, and in the recent launch of the first Northeastern Ohio regional marketing campaign. Furthermore, the Fund has leveraged the combined strengths of multiple communities and funders and set in place the strategies for development of what was once rated as the worst place in the nation to start a business. In just a few years, the Fund has helped the area rise from 61st (dead last) in Entrepreneur Magazine's rankings of the best and worst places to be an entrepreneur to 23rd, and about 100 regional companies have raised over $500 million in capital, including important growth in emerging industries like health care and clean energy. [36]

4.26. Fostering Cross-Sectoral Partnerships & Academic Partnerships

The GAVI Alliance brings together a broad range of partners who share the goal of improving "child health in the poorest countries by extending the reach and quality of immunization coverage within strengthened health services." Partners include UN agencies and institutions (UNICEF, WHO, the World Bank), civil society organizations, public health institutes, donor and implementing country governments, private philanthropists, vaccine industry representatives, and members of the financial community. Each of the partners makes distinctive contributions to the group based on their capabilities. For example, the International Vaccine Institute provides guidance to the research agenda, a communication platform with the research community, and technical staff for GAVI's operations. Philanthropy has played an important role in the Alliance as well, with critical startup funding from the Bill and Melinda Gates Foundation. [36]

Wharton's Dean, Professor Thomas S Robertson, says his school has three priorities: innovation, global presence and social impact. They are also "focused on hiring faculty from around the world and internationalizing the curriculum." Rather than establishing a campus in India Wharton want to set up a strategic relationships like the one with ISB and develop India---specific content which they can put online. [31]

4.27. Communicate

Good communications practices are essential to an innovation culture. Organizations need a process to create and share information in order to reduce uncertainty generated around innovation and the change it produces. Linked to the learning dimension of innovative culture, the communications' capacity enables broader participation in the innovative process. Good communications enable organizations to welcome innovations and innovators; poor communications can contribute to the destructive temptation for one person or faction to "kill off" the innovations of others in order to keep their own competitive advantage. [36]

Encourage people to get out of their offices and silos. Encourage people to meet informally, one-on-one, and in small groups. Encourage everyone to communicate. Provide user-friendly systems to make this happen. Improve the way brainstorming sessions and meetings are facilitated in your organization. Stimulate interaction between segments of the company that traditionally don't connect or collaborate with each other. [334]

Laszlo Bock, Senior Vice President of Google's People Operations stated that "We try to have as many channels for expression as we can, recognizing that different people, and different ideas, will percolate up in different ways." The channels include:

- Google Cafés, which are designed to encourage interactions between employees within and across teams, and to spark conversation about work as well as play.
- Direct emails to any of the company's leaders.
- Google Moderator, an innovation management tool designed by Google's engineers. The simple idea behind it is that when people have tech talks or company-wide meetings, it lets anyone ask a question and then people can vote up the questions that they'd like answered. Through Moderator, people can discover existing ideas, questions or suggestions, vote for ideas, questions or suggestions and see the aggregate votes to date, create a new series asking for ideas organized by topic, event or meeting. Google Moderator itself is one of Google's infamous "20 percent" projects. By allowing its engineers to spend 20% of their work week on projects that interest them, Google is able to tap into the many talents of its employees.
- Google+ conversations
- TGIF: Google's weekly all-hands meetings, where employees ask questions directly to the company's top leaders and other execs about any number of company issues.
- Google Universal Ticketing Systems, or 'GUTS', which is a way to file issues about anything, and is then reviewed for patterns or problems.
- 'FixIts', 24-hour sprints where Googlers drop everything and focus 100 percent of their energy on solving a specific problem;
- Internal innovation reviews, which are formal meetings where executives present product ideas through their divisions to the top executives;
- A wide range of surveys. [654]

4.28. Experiment and Learn

The realm of innovation is inherently filled with the unknown and unknowable. Only a culture willing to experiment, test, and learn will be able to produce and sustain innovation over time. New ideas simply aren't meaningful unless you are able to put them into practice and test how well they work. Effective experimentation and learning requires a commitment to trying new things and clear methods for capturing information and transforming it into insight that accelerates innovative thinking and actual innovations. [36]

When Caterina Fake and Stewart Butterfield launched **Flickr**, did they work out the perfect business model in advance, then launch the site? No. They started out building massively multiplayer online game – Game Never ending, which became relatively successful, just not successful enough to keep the company afloat. So the team built a site around a photo-sharing protocol that they developed for the game, and that became Flickr. **It was business model development through trial and error**. [674]

4.29. Fail Forward, Embrace failure & Failure as a Learning Opportunity

Aditya Ghosh, President, Indigo Airlines stated that "There are no limits to how much you can innovate. What is the key to it is how you create the culture of innovation. How do you let people make mistakes so they have a power to think out of the box? One of my favorite quote is by Michael Jordan who said "I have failed over & over & over again in my life, and that is why I succeed". We need to create a culture where people are allowed to make the same mistake again without being fearful. The only difference when you make a mistake the 3rd time is that it takes less time to realize that you made a mistake and this helps in encouraging people to think differently. If I am scared of making a mistake, I will never start thinking slightly out of the box. That is antithetical to creating a culture of innovation. So, first we have got to enable people to make that mistake and empower people to do things on their own and this will help people to follow the culture of innovation." [558]

Ideas are more common than the successes they're intended to enliven. Without a surplus of meritorious candidates, the vine of ideas will inevitably whither. I understand that "failing" is a difficult belief to personify. After all, failing means just that, to be unsuccessful in meeting goals or standards. Nevertheless, fear of failure contributes to risk aversion. Failing doesn't have to carry such negative overtones. Failing really means that you tried something and it didn't work out. At least you tried. As long as you tried and learned…quickly…then you can move on. If it wasn't for trying something new, we would be forever stuck in routines. And routines lead to complacency or irrelevance. Truth is that people will remember your hits over your misses. Edison failed 10,000 times before he made the electric light. The best companies find and communicate success even in failure. It's how we learn. [48]

In most companies, people are so afraid of making mistakes that they don't pursue their dreams. The simply follow the rules and keep their heads down, **which drives nothing but mediocrity**. In fact, nearly every breakthrough innovation in history came after countless setbacks, mistakes, and "failures." The great innovators and achievers weren't necessarily smarter or inherently more talented. They simply released their fear of failure and kept trying. They didn't let setbacks or misfires extinguish their curiosity and imagination. Failing forward means taking risks and increasing the rate of experimentation. Some bets will pay off; some will fail. The key is to fail

quickly. The speed of business has increased dramatically and every minute counts. The best businesses try lots of ideas and let the losers go quickly and with no remorse. [12]
Help your employees to embrace failure as a learning opportunity. Google staff are encouraged not to worry if an "experiment in innovation" fails. There is often something that can be learned or salvaged from any attempt. [36]

James Dyson, the inventor of the Dyson Vacuum cleaner, "failed" at more than 5,100 prototypes before getting it just right. [12]

Trying something new involves change, risk and the possibility of failure. An organization that wants to encourage new ideas has to develop a culture of trust and openness and look to remove barriers. A creative team has to communicate, share and understand each other's contribution, embrace diversity, question and challenge each other. An innovative individual needs a safe environment to express themselves, to know that their ideas are valued, there is a way to record them, share them, and take them forward. They need to be open to new experiences, and recognize opportunities. [26]

3M Corporation has created measurement and reward systems that tolerate mistakes and encourage success. 3M rewards successful innovators in a variety of ways:

- The Carlton Society, named after former company president Richard P. Carlton,
- Honors top 3M scientists who develop innovative new products and contribute to the company's culture of innovation, and the Golden Step is a cash award. [603]

Susan Wojcicki, Google's Senior Vice President stated that "Google is known for YouTube, not Google Video Player. The thing is, **people remember your hits more than your misses**. It's okay to fail as long as you learn from your mistakes and correct them fast. Trust me, we've failed plenty of times. Knowing that it's okay to fail can free you up to take risks. And the tech industry is so dynamic that the moment you stop taking risks is the moment you get left behind. Two of the first projects I worked on at Google, AdSense and **Google Answers**, were both uncharted territory for the company. While AdSense grew to be a multi-billion-dollar business, Google Answers (which let users post questions and pay an expert for the answer) was **retired after four years**. We learned a lot in that time, and we were able to apply the knowledge we had gathered to the development of future products. **If we'd been afraid to fail, we never would have tried Google Answers or AdSense, and missed an opportunity with each one**." [652]

4.30. Manage Accountability

"In a culture of innovation, accountability is critical. It's **not just employees** who are responsible for generating ideas and improving skills and expertise, **managers too** are measured by how well they cultivate ideas, spark imagination, and encourage collaboration." More so, managers are answerable for how well they promote ideas toward experimentation and implementation programs. Leaders lead. And for a healthy culture of innovation, one that strives to earn relevance, solve problems, and create new and even improbable opportunities and solutions, managers and executives are held to the same if not higher standards as everyone else. Eventually hierarchies fall in favor of flatter, more nimble models that move beyond just competing. This gives way for product strategies and also the way people work together, to become more than just competitive, they become the industry standard. [48]

4.31. The Change Heard Round the World

Innovation begins with an idea on how to improve something that may or may not be broken. The secret to change is that **it can arise from anywhere led by anyone**. Optimism and hope are contagious. To fight for resilience and transformation falls upon those who believe that the path to success is not charted by any one single route or any one person. Instead, the journey toward triumph is actually fought for and realized as you go. It takes change agents and revolutionaries. It takes you. [48]

4.32. Hunt for Talents, Bring the Right People, Creative Mind, Find the People with Ideas & Develop Community of Innovators

After you've gotten to know your lieutenants— your natural change leaders who really embrace innovation and push for new and different ways of doing things—and you've learned the problems facing the rest of the managers and leaders within your organization and how you can help solve them, you need to find those people who have the ideas. [13]

When it comes to innovation you need to keep in mind that **no idea is a bad idea**. That's one of the key things in building a true culture of innovation: training yourself to be non-judgmental in the beginning. When your team is in the idea stage you don't want to kill anything. You want to keep it all alive and be very open and accepting to anything that's coming in. When it gets a little farther down the path, after you've gotten a lot of the ideas out, that's when you start to critique them. There are ideas that are more relevant to problems you're trying to solve, and you can use that relevance as a means to start critiquing. [13]

Heather Yurko, CISCO stated that "One way I do this is to lead **Innovation Days**. We spend one day each quarter identifying problems that, if we solved them, would lead to better scores on our KPIs. We talk through the key things that need to get solved either for us as an organization, for our clients, or for our customers. We involve people at all levels, especially individual contributors, interns and new graduate hires—all the way up to directors and V.P.s, who will bring the problems they want to solve. We then narrow the presented problems down to the one we think would have the most value to the team if we solved it. That's our focus for the next month. We'll talk through the problem and look at a number of different angles on it: Will it make us a first mover? Will it significantly impact a critical business priority? Then we'll start to work through some potential solutions." [13]

So, if you're Apple, how do you recover? The common advice from most management books on building teams has typically been to: "hire for attitude, train for skills." This model better ensures harmonious work environments and friendly collaborations. Yet, in the world of innovation, aspirations and attitude aren't enough. In the situation that it found itself in, Apple needed real skills, and so when Steve Jobs compiled the iPod team he loaded the odds in his favor by going with his **very best people in hardware, software, and design**. A team was assembled because they were the best. And putting the best skilled on a mission to change the world, drove competition within them, leading the team to perform at peak levels – nobody on that team wanted to be "second-best!"[624]

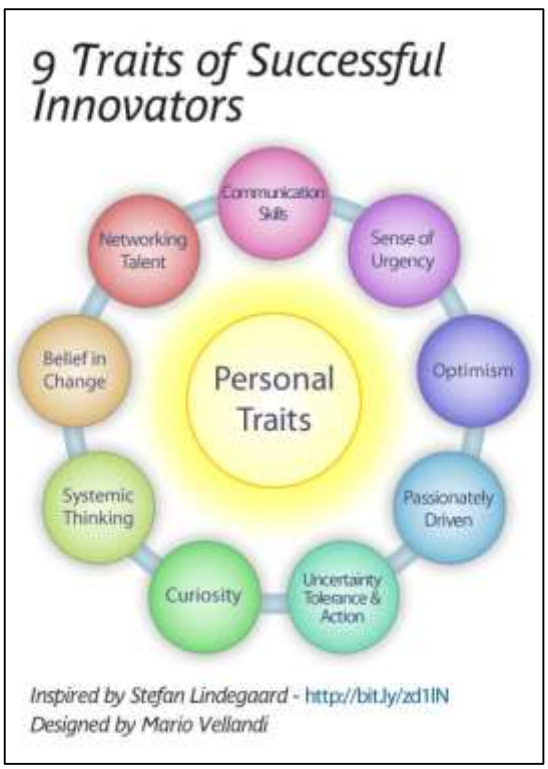


Fig.4.12: Hunt for Talent: 9 Traits of successful Innovators [637]

4.33. Form an Innovation Management Team

True leadership is a rare trait. Often top executives need to band together to create alignment and build the infrastructure necessary to support a culture of innovation. This team is responsible for establishing the charter and working with the key department heads necessary to research, prioritize, plan, test and learn, and establish best practices. More importantly, its responsible for integrating insights and new programs and processes throughout the organization. [48]

4.34. Tap the Creativity of "Lead Users" & Find Leaders and Influencers

Generally speaking, no one person is going to move an entire organization in a new direction, and so the more people you can bring along with you in building that culture of innovation the better. If you're coming into an organization as a new team member and starting from the ground level, you will need to learn who the key leaders and influencers are, recognizing that their leadership may have nothing to do with their job title or role. [13]

> HopeLab intentionally engages young people—its target constituency—in the development of ideas. This type of "lead-user innovation" encourages individual consumers and end users to modify existing products and services or to create entirely new ones that meet their specific needs. [36]

4.35. Tap the Potential of Own Nation

> Eastern Electrolyser decided they wanted to develop their business by investing in new technology. They set about finding IP from around the world that they could use in the Indian market. During their search they visited Singapore and happened to meet with an employee of the US Department for Energy. He asked them why they weren't looking in their own back yard and suggested they visit the Centre for Electro Chemical Research Institute in Tamil Nadu. Shivam was amazed with what they discovered. Here in the sleepy town of Karaikuddi near Madurai was a research institute specializing in the fields they were interested with 1000 PhDs. Eastern Electrolyser bought exclusive licenses and are now working with the institute scale up and commercialize various technologies. The institute already has various commercial tie-ups with companies like Asian Paints and Dupont but is eager for more. Shivam has been impressed with the quality and innovation he had no idea he could find on his own doorstep. They are now working with the Indian Navy to develop weather balloons. The company is now looking at fuel cells. Unlike their foray into electrolyzing technologies the first place they went to this time was another CSIR – the International Advanced Research Institute's Centre for Fuel Cell Technology in Hyderabad. [31]

4.36. Challenge People to Take Risks, Make them Comfortable for Taking Risks, Encourage Courage & Develop Fearlessness

People are more creative and innovative when they are free to share honest ideas. Accepting risks is the first step to taking them. View failure as a learning opportunity, and don't fail the same way twice. Allow enough time for innovative ideas to develop, and encourage champions. [54]

Help them get comfortable with taking risks.

When management reacts negatively to a new idea or a failed project, it creates a fear of failure. A failure to fail results in completely predictable, in-the-box thinking, and a massive roadblock for innovation. [54]

"Do not be afraid of day-to-day failures — learn from them. Cherish your history, both the successes and mistakes. All of these behaviors are the way to get better at programming. If you don't follow them, you're cheating your own personal development." [55]

> As they say at Google, "don't run from failure — fail often, fail quickly, and learn." [55]

> Netflix as a company is known as much for its culture as for its innovative business model. The company has built a business that is growing rapidly by allowing individuals the freedom to take creative risks without that overwhelming sense of fear or judgment. They tell their employees to "Say what you think, even if it is controversial. Make tough decisions without agonizing excessively. Take smart risks. Question actions inconsistent with our values." [12]

> Another great example: A software company in Boston gives each team member two "corporate get-out-of-jail-free" cards each year. The cards allow the holder to take risks and suffer no repercussions for mistakes associated with them. At annual reviews, leaders question their team members if the cards are not used. It is a great way to encourage risk taking and experimentation. Risky? Perhaps. Think this company comes up with amazing ideas? Absolutely. [12]

Successful innovation efforts cultivate a climate of smart risk-taking and make a point of learning from, not punishing, failure. At the same time smart organizations don't confuse low or non-performance with the more creative "failure" of innovation efforts. Be clear on what is an appropriate and acceptable risk tolerance for your organization and adapt an approach to innovation to match that level of risk tolerance—financially as well as strategically. For-profit and nonprofit/philanthropic entities have overall different levels of risk tolerance—with most companies exhibiting higher levels if and when they have generous research and development budgets and latitude for experimentation. The intensities of the "life and death" responsibilities of many nonprofits for people who rely on their services, along with more stringent budgetary boundaries, can lower the ability to take multiple or high-stakes risks. Philanthropic institutions have more financial flexibility for risk, yet often operate within tight strategies or restrictions imposed by the donor. [36]

4.37. Teach Your Employee "Innovation is not Optional"

Though initiating an innovation pipeline takes time and resources, it is no longer an optional strategy. Treating it like a superfluous initiative is a particularly disruptive cultural trait that causes companies to fall behind and fall apart in the face of increasing competition. [54]

4.38. Promote Creative Time

Allocate personal time for individuals to spend on innovation. Employees are given "20 percent time" to pursue "pet" projects, unrelated to their core work, that they find interesting. Half of the new launches at Google emerged from this sanctioned time for innovation. [36]

Spend 15% of your time and budget on new ideas, projects and ventures. Great ideas emerge over time.

3M uses a research and development focus and a unique "15% rule" to ensure continuing effort on expanding the pie. 3M spends approximately 6% of sales on research and development (PDF), far more than a typical manufacturing company. This has resulted not only in new products but also the creation of new industries. David Powell, 3M's vice president of marketing, affirms R&D's importance: "Annual investment in R&D in good years— and bad— is a cornerstone of the company. The consistency in the bad years is particularly important." William McKnight, who rose from his initial bookkeeping position to eventually become chairman of 3M's board, best explained the logic of the 15% rule: "Encourage experimental doodling. If you put fences around people, you get sheep. Give people the room they need." 3M engineers and scientists can spend up to 15% of their time pursuing projects of their own choice, free to look for unexpected, unscripted opportunities, for breakthrough innovations that have the potential to expand the pie. [603]

Mike Morrison, dean of the University of Toyota, said that one approach to engaging employees is to "incubate" their ideas. "You can't wait by the phone for a breakthrough idea," he said. "You need knowledge, technique, and motivation. If one element is missing, you can't have an innovative environment." Morrison said that **when people are relaxed, ideas begin bubbling to the surface**. So at Toyota, they periodically take people out of their typical office environments and let them develop ideas in places where the pressure is off and they can brainstorm without the demands of the workplace competing for their attention. The company also provides those people with lots of information and reading material on the subject at hand, hoping to inspire them to create bigger and better ideas than those that already exist. These incubation periods yield the breakthrough ideas Toyota is looking for, Morrison said. [258]

> Some employees in the infection-prevention division of 3M Corporation used their "15% time" to pursue wirelessly connected electronic stethoscopes. The result: In 2012, 3M introduced the first electronic stethoscope with Bluetooth technology that allows doctors to listen to patients' heart and lung sounds as they go on rounds, seamlessly transferring the data to software programs for deeper analysis. [603]

> A 60-watt bulb is good for 800 to 1,000 hours. Fluorescents are worth at least double that. Simpson didn't realize how wasteful that was until one day in June 2009, when a coworker named Ray Johnston approached him with a new idea. They could combine several technologies including the same mirrored film that helps light most laptop and cell phone screens and channel it, creating a "light guide" for bulbs that managed output from a low-wattage LED. The result would be a sort of super-bulb that burned brighter, stayed cooler, and lasted way longer than traditional offerings. It also would emit light in a natural way—a shortcoming of other LED offerings which act more like lasers than light-bulbs. In 2008, he was manager of the Advanced Concepts group within 3M's Display and Graphics Lab, a team with 20 engineer and scientists, in charge of spotting and bringing bright new ideas to market. The result, the 3M LED Advanced Light-bulb, costs $24.88 and was released exclusively through Walmart last August. It burns for 27,500 hours—that's more than 13 years of all-day office life. [612]

4.39. Ensure that the Fiscal and Temporal Resources Necessary to Accomplish Tasks are Available

If an organization has an "innovation fund" that enables good ideas to get going, then individuals will likely view innovation in one way. If an organization penalizes individuals who seek external funding, then they are likely to view innovation as secondary or unnecessary. [1]

4.40. Time Deadlines and Creativity

Another kind of resource is time. Of course, time pressures and deadlines can stimulate creativity. They also can help individuals accomplish tasks. Research also shows that **if people are constantly working under deadlines, they do not look for creative solutions**; they are not innovative. They 'satisfice' – they simply choose a decision that will enable them to meet a deadline. If innovation is important, then it should be factored in to the way the organization thinks about how individuals should spend their time. A university that has individuals teach 100% of their time or finds that the cheapest way to have teaching covered is by hiring adjuncts may be solving one problem, but they are not creating a culture of innovation. A culture of innovation suggests that a particular part of an individuals' work is geared toward innovative activities. [1]

4.41. Measure and be Accountable

As companies and organizations try to prove whether or not their various investments in innovation are "paying off" there is a new field emerging to **"measure" innovation by creating accepted systems of metrics**. The U.S. Department of Commerce recently formed an advisory committee to bring together business, academic and philanthropic leaders to define innovation and to explore the options for measurement. While no standards currently exist to measure "innovativeness" or the effectiveness of investing in innovation, there is much attentiveness to feedback and learning from innovations as they move from idea to practice. Organizations do this in a number of ways, from eBay's feedback process on every transaction to the Women's Funding Network's "Making the Case" tool for participatory evaluation of social change with grantee partners. The preference for rapid cycling of testing and improving ideas dominates both literature and practice right now; and Cisco Systems has boiled it down to a slogan: "Instant feedback creates instant success!" Measuring and assessing effectiveness is a critical element of an organization's ability to effectively experiment, test, and learn. [36]

4.42. Think Small

ITW is a diversified manufacturing company that produces a wide array of products from industrial packaging to power systems and electronics to food equipment to construction products. It is a highly profitable $16-billion company that is nearly 100 years old. Yet this big, old company, which is nestled in a traditional industry, thinks small. The leaders at ITW believe that being nimble, hungry, and entrepreneurial are the ingredients for business success. As a result, any time a business unit reaches $200 million in revenue, the division "mutates" into two $100 million units. Like an amoeba, the unit subdivides so it stays small, hungry and nimble. The company would rather have 10 independently run and innovative $100 million units than a single, bureaucratic, and clunky $1 billion unit. Guess what? It's working. Smaller companies tend to be more curious and nimble. They have a stronger sense of urgency and are not afraid to embrace change. In contrast, larger organizations often exist to protect previous ideas rather than to create new ones. [12]

4.43. Analyze the Innovative Ideas

After the idea generation stage is over, we look through the ideas and judge them through applying criteria around it. We ask questions like, "How much revenue could it generate? How much cost could it avoid? How many clients could it impact?" [13]

4.44. Democratize Innovation

Not all innovation is completely new; in fact, innovation most often is a tweak on an existing idea or the unexpected juxtaposition of existing ideas. As such, innovation can come from anyone and anywhere. This is leading to more extensive organizational practices to discover internal innovation as well as to open up to external ideas and processes. Often referred to as the "democratization" of innovation, this practice recognizes and encourages a wide range of people to participate in the generation of new ideas, the translation and adaptation of existing ideas to new circumstances, and the combination of multiple existing ideas into a new concept. Empowering people is essential. If it is a good idea that can be prototyped, implemented, refined and disseminated, the source is of little importance. [36]

4.45. Change Agents are Needed

Senior leadership support for innovation is important, of course. But an organization also needs specialists who can foster innovation throughout the organization, both on specific projects and in structural ways that impact daily operations. [36]

4.46. Encourage Volume, Speed, and Iteration

> Google pilots products early and often, in small beta tests. This allows people to test out ideas with others, and to iterate and refine the ideas, before launching them more broadly. [36]

4.47. Open up the Innovation Process & Provide a Full Range of Support for Innovators

Rather than choosing a select set of "fellows" or finding innovators through a regular grant making process, the Civic Innovation Lab and HopeLab attempt to open up the innovation process to attract **talent and ideas from people everywhere**, across geographies and sectors. Prize money and aspirational social visions help attract applicants and creativity. Develop a culture that supports, nurtures, and develops innovation in a systematic way. Creativity is only one part of the innovation picture. A disciplined yet flexible process is needed to launch new ideas and then scale them to the opportunity or problem at hand. Social innovators often need more than just capital. The Civic Innovation Lab surrounds its innovators with a wide range of supports, including mentorship, information and advice, connections and networks, and public visibility. Innovation requires visible and vocal top management commitment, supported by aligned resources and incentives. Once leaders give their signal of support for innovation, they open a call for innovation to all. At the same time, leaders must find some people with core competencies in innovation to lead specific efforts to integrate innovative pursuits. An organization that wants systemic commitment to innovation will want to recruit, train, nurture, and reward innovative behavior of staff and leaders.

> The best companies seem to be managing a balance of a few high-profile programs aimed at getting employees to think differently and more fundamental processes that make sure the work actually gets done. **IBM**, for instance, made a splash last year with its **InnovationJam**. This online event brought together 150,000 IBM employees, business partners, and even customers to bat around new areas where IBM's technologies could be put to good use. Chief Executive Samuel J. Palmisano later funded the 10 best ideas. [666]

[36]

4.48. Sometimes Tighten the Purse Strings

“Constraint breeds innovation,” says Clarke. “It’s very tempting, when money and resources flow freely, to stick with tried and true solutions. When money and resources are constrained, you have to find new and creative ways to solve problems.” [261]

4.49. Delegate the Firefighting

“You cannot drive innovation while you’re putting out operational fires,” says Carl Ascenzo, CIO of Blue Cross Blue Shield of Massachusetts. “Hire the best operations team you can, and stay out of their way.” [261]

4.50. Establish Credibility

Trust breeds innovation, and communication breeds trust. Establish a formal communication program. [261]

4.51. Accept and Seek Criticism

"Not every idea is a good one, and some are downright lousy," says Dave Clarke, VP and CTO at the American Red Cross. "To improve your ideas, ruthlessly seek out criticism. If you can't bear to hear that your baby's ugly, you won't be a successful innovator." [261]

4.52. Look Around

Staying inside your organization and keeping the lights on may be instinctual during down times, but it is hardly a pathway to innovation. "You have to look outside your frame of reference," says Kent Kushar, CIO of E&J Gallo Winery. "You don't have to be the first wagon out of the fort, but if you want to be a fast follower, you have to get out there with your customers and see what's going on." The same goes for your staff, says Larry Brown, CIO of Arch Coal. "The people in the trenches need to know that they have the flexibility to look at innovative alternatives." [261]

4.53. Customer as Innovation Partner

Make customers your innovation partners, while realizing that customers are often limited to incremental innovations, not breakthrough ones. [334]

4.54. Telling Stories of Famous Failures that Subsequently Created Breakthrough Products

3M, the topmost innovative company of the world, also has a rich tradition of telling the stories of famous failures that subsequently created breakthrough products— such as the weak adhesive that inspired Post-It notes— to ensure a culture that stays innovative and risks failure for unexpected rewards.

Another 3M failure story from its early days, still repeated inside the company: 3M's initial business venture was to mine corundum, a material they planned to use to make grinding wheels. Instead, what they found was inferior abrasive. After much experimentation came their first breakthrough product: Wetordry sandpaper. [603]

4.55. Pursuit of Improvement

> While Dell is not recognized as a product innovator, the company was very innovative in its factory processes, supply-chain management, and make-to-order e-commerce systems. Its efficiency strategies worked quite well for a number of years – giving Dell cost and quality advantages over its "IBM-PC compatible" rivals and Fortune 500 status. Dell got FDH, Michael Dell left for a while, and innovation went by the wayside. So did sales. [610]

4.56. Necessity Is Not the Only Mother of Invention

Companies such as 3M and Apple chose innovation at a point in their histories when they **did not have much choice**. For them, necessity was the mother of invention. 3M institutionalized their innovative ways. Time will tell if Apple will continue to innovate now that Steve Jobs has passed. [610]

We should be most concerned about companies that are currently successful that do not have innovation ingrained in the fabric of their businesses. They are the ones that need to avoid the FDH (fat, dumb, and happy) syndrome, try new things and not rest on their laurels. They have to risk failure to continue to achieve great success. They should know that survival today requires more than treading water, and that many of the companies that were once great are now gone or on their way out largely because they stopped innovating. In fact, **according to Forbes, the average lifespan of a successful S&P 500 Company was 67 years in the 1920's. Today it is 15 years. More companies need to innovate to improve these declining numbers**. [610]

4.57. Innovation Can Be Incremental

The innovations do not have to be revolutionary or the exclusive domain of new or improved products. The improvements can be incremental as they are at Toyota, or they can be in business systems and processes as they were at Dell. Innovations can (and should) be in marketing as they have been at Procter & Gamble. Some may recall that the company invented the "soap opera" to sell its soap. [610]

4.58. Multiple Career Path

At 3M Corporation, Researchers can choose to follow a technical career path or a management career path, with equal advancement opportunities. This option is offered successfully by a number of technology firms, allowing researchers to more fully develop their technical professional interests without being penalized financially for not going into management. [613]

4.59. Look Forward

Kodak's story is even more poignant. It is a deep irony that Kodak invented the digital camera in 1975 and holds over 1000 patents in digital imagery. The 130 year-old company was always technically highly innovative, and clearly foresaw the trend towards digital technologies, but it was so heavily invested in film technology – essentially a chemical process – that it became strangled by its own legacy, failed to chart a effective path to the digital world, and has now filed for bankruptcy protection. It didn't commercialize this invention because it wanted to protect its film business. The Company had what I call the "FDH" syndrome. It was "Fat, Dumb, and Happy" with its success in film. It looked backward instead of forward. As Bill Gates is fond of saying, "Success is a lousy teacher. It seduces smart people into thinking they can't lose." To be innovative, you cannot be afraid to obsolete your own products. If you are, others will obsolete them for you. [610] [647]

4.60. Define the Kind of Innovation that Drives Growth and Helps Meet Strategic Objectives

When senior executives ask for substantial innovation in the gathering of consumer insights, the delivery of services, or the customer experience, for example, they communicate to employees the type of innovation they expect. In the absence of such direction, employees will come back with incremental and often familiar ideas. [625]

4.61. Add Innovation to the Formal Agenda at Regular Leadership Meetings

We observe this approach among leading innovators. It sends an important signal to employees about the value management attaches to innovation. [625]

4.62. Set Performance Metrics and Targets for Innovation

Leaders should think about two types of metrics: the financial (such as the percentage of total revenue from new products) and the behavioral. What metrics, for example, would have the greatest effect on how people work? One company required that 20 percent of its revenue come from products launched within the past three years. Another established targets for potential revenues from new ideas in order to ensure that they would be substantial enough to affect its performance. Leaders can also set metrics to change ingrained behavior, such as the "not invented here" syndrome, by requiring 25 percent of all ideas to come from external sources. [625]

4.63. Designing Innovation Networks

Since new ideas seem to spur more new ideas, networks generate a cycle of innovation. Furthermore, effective networks allow people with different kinds of knowledge and ways of tackling problems to cross-fertilize ideas. By focusing on getting the most from innovation networks, leaders can therefore capture more value from existing resources, without launching a large-scale change-management program. [625]

4.64. Imagination and Communication

In order to achieve this, the innovative leader needs a powerful imagination and excellent communications skills. She also needs to have confidence in her team and their ability to work together to achieve that dream. The innovative leader is not a micro-manager. She focuses on the big picture and works with creative thinkers who can add to that vision and make it greater. Micro-managers, on the other hand, tend to stifle creativity and focus far too much on the details – causing them and their teams to lose sight of the big picture. Perhaps most importantly, the innovative leader needs to be able to communicate her vision and generate enthusiasm for it. Her team needs to be able to see the vision themselves and be willing to invest their own time and resources into making it happen. Innovative leaders know that leadership by demand is far less effective at encouraging creativity and innovation than is leadership through motivation and inspiration. Ideally, team members will also be making creative contributions to the project. After all, innovative projects are almost never comprised of a single idea. Although they may have got their start from a solo idea, in the end they are the result of dozens or more ideas, ideas on improving the original concept, ideas on how to implement it, ideas to solve problems as the concept is developed and so on. [638]

4.65. Have a Vision for Change

You cannot expect your team to be innovative if they do not know the direction in which they are headed. Innovation has to have a purpose. It is up to the leader to set the course and give a bearing for the future. You need one overarching statement which defines the direction for the business and which people will readily understand and remember. Great leaders spend time illustrating the vision, the goals and the challenges. They explain to people how their role is crucial in fulfilling the vision and meeting the challenges. They inspire men and women to become passionate entrepreneurs finding innovative routes to success. [639]

4.66. Think like a Venture Capitalist

VCs use a portfolio approach so that they balance the risk of losers with the upsides of winners. They like to consider a large number of proposals. They are comfortable with the knowledge that many of the ideas they back will fail. These are all important lessons for corporate executives who typically consider only a handful of proposals and who abhor failure. [639]

4.67. Guiding strategic Collaborations

Effective leadership will demand new skills for guiding sophisticated collaborations undertaking complex projects. Leaders will need a new set of strategy skills beyond the traditional frameworks of strategic planning. [640]

4.68. Crossing Boundaries and Integrating Diverse People and Activities in a Team

On a personal level, the skill involves thinking outside your box and working in a team with people from other organizations. Our organizational level, question is whether the organization promotes and rewards people who work across organizational boundaries. [640]

4.69. Change Your Perspective

The human brain tends to screen in data that proves us right and screen out anything that contradicts our prevailing point of view. As a result, we often filter, distort, or ignore the information coming in, so that we **only see what we want to see**. Changing your perspective enables the brain to break out of its rigid thinking patterns and see the world in new and different ways. It opens the mind to new possibilities, and focuses your attention on what could be rather than what is or what was. It also enables you to spot new patterns and connections that others might not see – a critical factor for successful innovation. Changing your perspective doesn't mean throwing out all your old ideas. Just the ones that get in the way of ongoing innovation. [644]

4.70. Challenge Your Assumptions

The biggest enemy of innovation is the unspoken attitudes and beliefs we cling to about our customers, markets and businesses. And the more success we achieve based on those assumptions, the more we tend to focus on protecting the status quo versus exploring what could be. To develop the skill of challenging your assumptions, ask: What has changed with our customers, markets, industry, or the world at large? What assumptions are we continuing to make about our business simply because we "know them to be true"? What ideas for new products or services have we come up with recently but didn't follow through because "that will never work"? Today's market leaders get ahead by shedding old ideas and ways of thinking faster than their competitors. This can only happen by challenging your assumptions on a regular basis. [644]

4.71. Stop Jumping To Solutions

Today's hyper-fast business world creates a lot of pressure to make quick decisions. So we often tend to go with the first feasible solution rather than looking for better or different ideas. Not a good recipe for ongoing innovation! To encourage your team to look for different and/or better solutions, ask, "What underlying attitudes or beliefs are causing us to see this as the best or only solution?" Then solicit alternative viewpoints from people who see things differently. For example, "It sounds like we're all in agreement on the solution here. Does anyone see it differently?" [644]

4.72. Important Power Thinking Skills for Innovative Leadership

Valeri Souchkov, TRIZ and Systematic Innovation expert certified by the founder of TRIZ Genrich Altshuller has explained the thinking strategies in his article "Power Thinking Skills For Innovative Leadership". They are as follows (refer the article for more details) [645]

- Multi-Screen Thinking vs. Spot Thinking
- Abstract Thinking vs. Specific Thinking
- Breakthrough Thinking vs. Trade-off Thinking
- Intensification Thinking vs. Sheltered Thinking
- Non-linear Thinking vs. Linear Thinking
- Diversity Thinking vs. Uniformity Thinking

- Structured Thinking vs. Random Thinking
- Ideality Thinking vs. Consumption Thinking
- "Ultimate Goal" Thinking vs. Shallow Thinking
- Evolutionary Thinking vs. Random Thinking
- Long-term Thinking vs. Short-term Thinking
- Wild Thinking vs. Grounded Thinking
- Analytical Thinking vs. "Jump-to-Solution" Thinking
- Problem Flow Thinking vs. Single Solution Thinking [645]

I have included the first thinking strategy in the next section.

4.73. Multi-Screen Thinking vs. Spot Thinking

In most cases, when we attempt to solve a problem, we **usually focus on a very narrow spot where the problem takes place**. As a result we limit ourselves to considering only those components that immediately form the problem. However **looking at the problem from the viewpoint of its relationships with a rest of a system where the problem has arisen helps identifying much broader scope of opportunities, better understand roots and history of the problem, and identify different strategies of solving the problem at different levels**. Thus we should always try to see a problem as a part of a bigger system and also recognize how our future solutions to the problem will impact the future of a system and its environment. When we want to innovatively improve a certain system – technical, business, etc., - it also makes sense to look back to the past to find out what changes the system experienced and what were key drivers of these changes. Viewing a problem or a system under different angles also helps to recognize different types of solutions and evolution strategies. [645]

4.74. Passion for Innovation

Innovative leaders not only have to appreciate the benefits of innovation, they need a deep passion for innovations that benefit customers. Just approving funds for innovation is insufficient. Leaders must make innovation an essential part of the company's culture and growth strategy. [646]

> Bill George, Professor, Harvard Business School and former CEO Medtronic stated that "Amazon founder Jeff Bezos never wavered in his commitment to online retail marketing, even when the dot-com bubble burst in 2002 and Amazon's stock declined more than 90%. More recently, Bezos ignored short-term profitability to expand into hardware with the Kindle. Faced with mounting costs and technical difficulties, Amazon's financial chief asked him how much he was prepared to lose on this venture. Not flinching, Bezos replied, "How much money do we have?" He was so committed to this venture that he was prepared to stake the company's future on its success. As a result, **Amazon is transforming the book world from printed books to electronic**." [646]

Bill George, Professor, Harvard Business School and former CEO Medtronic stated that "When I joined Medtronic in 1989, it was evident that the innovation process had broken down. My first week, I was informed that all innovative ventures were being divested because they were losing money and the company needed improved short-term results. The company had many highly innovative people, who were demoralized by lack of senior management support. Engineering problems and product development overruns were absorbing all their funds. To solve both problems simultaneously, we created entirely separate organizations with different profit-and-loss structures and put disciplined leaders in charge of the established organization and innovative leaders in charge of breakthrough ideas.

To solve engineering problems, a highly disciplined engineer restructured the product development process. He cut new product lead times from 48 to 18 months with a rigorous approach that kept unproven ideas and innovation off the critical path. He selected disciplined engineers as project leaders and produced a steady stream of products resulting in near-term success. This provided the profits and cash flow to fund innovative ideas as well as refuel the product development process.

Meanwhile, two very innovative senior executives led the creative side: a scientific leader and a medical doctor with a keen interest in technology and innovative medical ideas. They created a series of venture projects addressing unmet medical needs. Although many projects failed, enough succeeded to propel Medtronic to sustain a growth rate in excess of 18% for a 20-year period. This **built the company from $400 million to $16 billion** in revenue and gave Medtronic a **reputation as "an innovation machine**." More important, innovations resulted in a dozen major medical breakthroughs to treat intractable disease, including original therapies for heart failure, spinal pain, cerebral palsy, and Parkinson's disease." [646]

4.75. A Long-Term Perspective

Most investors think three years is "long-term," but that won't yield genuine innovation. Major innovations can change entire markets as the iPod and iTunes did, but they take time to perfect products and gain adoption by mainstream users. Leaders cannot stop and start innovation projects as if they were marketing expenses; they must support innovation regardless of the company's near-term prospects. [646]

Vision of Innovation Leader: David Parekh, Vice President, United Technologies Research Center USA stated that “Let me take an example from UTC... Years ago, we launched a new engine, the geared turbofan engine, which is now part of the **Airbus 340**: this engine is **15% more fuel efficient** than previous ones, it **reduces noise by 50-75%** and **operating costs by 20%**. The company invested in this technology **15 years ago. Before, it was asked for by customers, before society taught broadly about green technology and energy efficiency, UTC’s leadership made a commitment to say this is something we believe in and want to support it.**

If you have leaders, politicians and others who truly understand the **importance of innovation** and technology and the need to creating those ecosystems, then I believe while they are balancing their budgets, they must not shy back from moving towards the European target of 3% of GDP invested in R&D. They must not shy back from investing in highly educated workforces and facilitating access to science and technology training. They must not shy back from the things they need to do to create the infrastructure that allows people to build innovative startups. **Innovation is not something that is planned**. You plan the development, plan execution, but often a lot of the creative ideas come from looking at an old problem in a new way. I think the diversity of bringing new skills and ideas together in one place where you foster that is key.” [643]

4.76. Deep Engagement with the Innovators

Innovative leaders must be highly engaged with their innovation teams: asking questions, probing for potential problems, and looking for ways to accelerate projects and broaden their impact. That's what HP's founders Bill Hewlett and David Packard did by wandering around HP's labs and challenging innovators. [646]

4.77. Willingness to Tolerate Mavericks and Defend Them from Middle Management

The best innovators are rule-breakers and mavericks who don't fit the corporate mold and are threatening to middle managers following more typical management approaches. That's why innovative leaders must protect their maverick's projects, budgets, and careers rather than forcing them into traditional management positions. [646]

4.78. Management is the Problem

Ian James, Programme Director for ICT at Gordon Institute of Business Science, University in Johannesburg, South Africa stated that “Management expert, Dr. Gary Hamel, cites **management as the prime inhibitor of innovation**. “Management was designed to solve a very specific problem – how to do things with perfect replicability, at ever-increasing scale and steadily increasing efficiency,” he says. According to Hamel, management as a discipline was designed over a century ago as a means of getting people to follow the goals of the organization. Today, however, the challenge is how to build organizations that enable creativity and initiative and “mobilize and monetize the imagination of each employee.” This cannot be done in a half-hearted way – for instance by establishing a token ‘innovation committee’ (an oxymoron if ever there was one) or even by creating an autonomous ‘new ventures’ division; it must become embedded in the culture of the entire organization – part of its DNA. Research conducted in 2007 by management consulting firm McKinsey revealed that although 94 percent of senior executives recognized people and corporate culture as the most important drivers of innovation, two-thirds were disappointed in their own ability to stimulate innovation in their organizations.” [647]

4.79. Have a Mission That Matters

Susan Wojcicki, Google's Senior Vice President stated that “Work can be more than a job when it stands for something you care about. Google’s mission is to ‘**organize the world’s information and make it universally accessible and useful**.’ We use this simple statement to guide all of our decisions. When we start work in a new area, it’s often because **we see an important issue that hasn’t been solved and we’re confident that technology can make a difference**. For example, Gmail was created to address the need for more web email functionality, great search and more storage. Our mission is one that has the potential to touch many lives, and we make sure that all our employees feel connected to it and empowered to help achieve it. In times of crisis, they have helped by organizing life-saving information and making it readily available. The dedicated Googlers who launched our **Person Finder tool** within two hours of the earthquake and tsunami in Japan this March are a wonderful recent example of that commitment. [651] [652]

David Lawee, Vice president, Corporate Development Google stated that “Google provides resources — infrastructure, money, time and people — **but most important, a vision** that tests most entrepreneurs to think bigger than they ever have before. We believe in big bets, and in high-risk and high-reward projects such as driverless cars and Android. By encouraging people to think bigger, we often achieve far more than what we initially imagine.” [686]

4.80. Required Different Leadership Skills in Open Innovation

Leadership Skills in Open Innovation requires more Collaboration and Different Control… when an organization opens its doors to the outside, even if it is just to watch the competition, a climate of insecurity or fear emerges within the leadership and management. Organizations have lived for many years within closed environments, so the approaches that address the challenges from open innovation, puts some tension on leadership and management approaches. When teams know how to manage this tension between- organization control and collaboration with exterior, and between technical and management contributions, it helps resolve personal and organizational conflicts. [648]

4.81. Think Big but Start Small

Susan Wojcicki, Google's Senior Vice President stated that "No matter how ambitious the plan, you have to roll up your sleeves and start somewhere. **Google Books**, which has brought the content of **millions of books online**, was an idea that **our founder, Larry Page**, had for a long time. People thought it was too crazy even to try, but he went ahead and bought a scanner and hooked it up in his office. He began scanning pages, timed how long it took with a metronome, ran the numbers and realized it would be possible to bring the world's books online. Today, our Book Search index contains over **10 million books**. Similarly, **AdSense**, which delivers contextual ads to websites, started when one engineer put ads in Gmail. We realized that with more sophisticated technology we could do an even better job by devoting additional resources to this tiny project. Today, **AdSense ads reach 80 percent of global internet users** – it is the world's largest ad network – and we have hundreds of thousands of publishers worldwide. [652] [653]

4.82. Look for Ideas Everywhere

Susan Wojcicki, Google's Senior Vice President stated that "As the leader of our Ads products, I want to hear ideas from everyone – and that includes our partners, advertisers and all of the people on my team. I also want to be a **part of the conversations** Googlers are having in the **hallways**. Several years ago, we took this quite literally and posted an ideas board on a wall at Google's headquarters in Mountain View. On a Friday night, an engineer went to the board and wrote down the details of a **convoluted problem we had with our ads system**. A group of Googlers lacking exciting plans for the evening began re-writing the algorithm within hours and had solved the problem by Tuesday. Some of the best ideas at Google are sparked just like that – when small groups of Googlers take a break on a random afternoon and start talking about things that excite them. The Google **Art Project**, which brought **thousands of museum works online**, and successful AdWords features like Automated Rules, are great examples of projects that started out in our 'microkitchens.' This is why we make sure Google is stocked with plenty of snacks at all times. [652] [653]

4.83. Share Everything

Susan Wojcicki, Google's Senior Vice President stated that "Our employees know pretty much everything that's going on and why decisions are made. Every quarter, we share the entire Board Letter with all 26,000 employees, and we present the same slides presented to the Board of Directors in a company-wide meeting. **By sharing everything, you encourage the discussion, exchange and re-interpretation of ideas, which can lead to unexpected and innovative outcomes**. We try to facilitate this by working in small, crowded teams in open cube arrangements, rather than individual offices. When someone has an idea or needs input on a decision, they can just look up and say, 'Hey…' to the person sitting next to them. Maybe that cube-mate will have something to contribute as well. **The idea for language translation** in Google Talk (our Gmail chat client) came out of conversations between the Google Talk and **Google Translate** teams when they happened to be working near one another." [652] [653]

4.84. Be a Platform and Have Openness

Susan Wojcicki, Google's Senior Vice President stated that "There is so much awe-inspiring innovation being driven by people all over the globe. That's why we believe so strongly in the power of **open technologies**. They **enable anyone, anywhere, to apply their unique skills, perspectives and passions to the creation of new products and features on top of our platforms**. This openness helps to move the needle forward for everyone involved. **Google Earth**, for example, allows developers to build 'layers' on top of our maps and share them with the world. One user created a layer that uses animations of real-time sensor data to illustrate what might happen if sea levels rose from one to 100 meters. Another famous example of open technology is our mobile platform, **Android**. There are currently over 310 devices on the market built on the Android OS, and close to half a million Android developers outside the company who enjoy the support of Google's extensive resources. These **independent developers** are responsible for most of the **200,000 apps** in the Android marketplace." [652] [653]

Unilever recently unveiled its **Open Innovation Initiative** that solicits new ideas for designs and technologies to tackle a range of challenges around health, hygiene and the environment. The company's Pureit home water purifier, which delivers safe drinking water to more than 30 million people across developing and emerging markets, was developed using this **open innovation model**. In April 2012, Unilever continued to display its commitment to open innovation by hosting a 24-hour live online discussion that generated 4,000 comments from over 2,000 thought leaders to give the company feedback on its sustainability goals. [676]

4.85. Create a Learning Culture

Knowledge fuels and underpins innovation. It allows possibilities to be seen and explored; it informs and guides direction by providing context, insight and understanding which in turn lead to new thinking, ideas and solutions. In most cases, once people leave school or college proactive learning becomes sporadic at best. A core trait of highly successful individuals however is they have an un-quenching thirst for learning and personal development; they seek knowledge and insights in all their forms and actively pursue opportunities to augment. Not only is this through reading books, texts, articles or interviews in their given discipline; attending events, workshops or seminars; or searching and exploring content online, but also through interactions with others – everyday meetings and conversations, or time spent with individuals who can specifically build their understanding, i.e. people who've been there and done it before. This form of absorptive education is crucial for the development of entrepreneurs. Companies must imbue values of endless self-improvement, knowledge seeking and development through the definition, articulation and ongoing experience of their core values as a means of instilling these principles across the workforce. [655]

4.86. Be Sensitive to External Changes

Creating an organizational 'nervous system' that is sensitive to external changes allows the business to innovate faster. Entrepreneurs need to think and react at speed if they're going to stay ahead of emerging trends and opportunities given the constant flux of today's markets and ever increasing competition. The organization therefore needs to provide its entrepreneurs with the intelligence to move quickly. Part of this is creating an internal and external data framework that drives consumable and actionable insights. However pure data alone is never enough; intelligence should always be augmented by a network of human gatherers who actively gain insights through building networks and contacts in the market. In this respect, it's important to consider how this intelligence is consolidated and disseminated across the business. In most cases, highly valuable knowledge is usually retained and guarded by individuals or teams without sharing; only by pooling this will the organization empower its entrepreneurs to create value and drive competitive advantage. [655]

4.87. Train Employees on Creating and Selling Innovation

One famously innovative company, **DreamWorks Animations** – the studio behind groundbreaking movie franchises including Shrek, Madagascar and Kung-Fu Panda – values and encourages creativity from all its employees, even support staff such as accountants and lawyers. According to **Dan Satterthwaite, Head of Human Resources**, **they actively solicit ideas and regularly receive hundreds from staff across the business**. Regardless of their defined roles, DreamWorks employees are **specifically trained on how to pitch their ideas successfully**, whether it involves creative input for a new movie or a food choice for the cafeteria. According to Satterthwaite: "The work that we do is so collaborative that we must have people who can not only sit at their desk and solve a problem, but then be able to articulate that solution to their supervisor and to the team." All employees also have access to courses such as artist development, giving them the skills, knowledge and aptitudes that have enabled DreamWorks to repeatedly come up with the next **blockbuster animated movie**. This inclusive, high engagement culture has consequently led DreamWorks to consistently gain high employee satisfaction rankings as a great place to work. As Satterwaite puts it: "**We challenge all our employees to be their own CEOs.**" [655]

4.88. Develop Healthy Competition

> Apple when a project gets to a critical stage, the company assigns three teams to its development, each of which competes against the other. [660]

4.89. Build A Team That Can Both Identify Gaps In The Market And Markets In The Gap!

We all know that a good business idea usually fills a gap in the market – the idea addresses some sort of unmet need for which there is no other solution currently available. That is an important start **but it isn't enough to be considered true innovation**. Innovation happens when there is not only a good idea, but also **real customers willing to pay for it** – that is to say, there is also a market in the gap. Surprisingly, innovation teams often neglect to bring in the skills required to ensure both of these two things happen. [673]

4.90. Find Team Members Who Tell Great Stories!

In our experience, the ability to communicate the new business idea is almost as important as the quality of the idea itself. Whether you are presenting to your boss, your colleagues or to a panel of Venture Capitalists, it is absolutely vital that they come away with a clear understanding of the concept's value proposition, and a shared enthusiasm to make it successful. A good storyteller can help make this a reality. [673]

> At Microsoft's Entertainment and Devices business unit, the design organization has spearheaded the use of visual methods and stories to present new consumer experiences. It has proven to be especially effective as a tool to communicate with the Engineers who are responsible for creating the technology that makes the new consumer experiences a reality. "They see one of our presentations and they get jazzed. Not only are they more enthusiastic, they also make less mistakes, allowing us to innovate faster," said one Microsoft Product Manager. [673]

4.91. Hire People with Different Perspectives

Look for employees who understand your vision and align with your culture but aren't necessarily the same as you. Look for those that may have different perspectives, diverse backgrounds, passions, and capabilities. Having employees with an alternative set of ideas and problem-solving approaches will easily generate an innovative approach. [675]

4.92. Encourages Independent Thinking

- FedEx, the company actively assists executives in moving between functions in order to accumulate a diverse range of experiences that improve their overall adaptability.
- Dow Chemical is another firm that encourages employees to move functionally and geographically to gain new perspectives on the business and build capabilities for independent thinking and problem-solving. [676]

4.93. Create a Safe Space for Innovation

- At Walmart, a group called @WalmartLabs provides a supportive environment for testing new ideas.
- Similarly, Toyota encourages innovation by removing some of the pressure for short-term returns. [676]

9.94. Toxic Questions: Guaranteed To Kill Innovation

Here are three toxic questions that you probably ask that are guaranteed to kill innovation:

- **"What is the return on investment on this project?"**: This question scares innovation team and forces them to tell lies. They simply cannot answer it because it's way too early to know what the ROI will be. So they either make up an answer and stretch the truth, or they throw buckets of speculative financial data at the question and hope no one notices that they aren't answering it.
- **"Can you prove your case and back it up with hard data?"**: Ask this question of an innovation team, and they will put all their energy into the wrong areas. They will try hard to extrapolate numbers from market trends and past experience, rather than thinking about customers, good ideas, and new paradigms.
- **"Are you meeting your milestones?"**: This question will force an innovation team to abandon anything controversial and go back to the concrete world that they already know. They might get something done, but it won't be innovative. Milestones suit a construction project where you know what you are going to build, but they are inappropriate for an innovation or learning project. [678]

9.95. Open Innovation and Partnership Programs

The partnership program isn't the only way GE intends to foster innovation. GE Global Research, the research and development division of the company, sponsors competitions for participants around the world to solve design and manufacturing problems. For example, one recent contest was a 3-D printing design challenge to make a better bracket for a jet engine. More than 700 participants from 56 countries were involved. In the end, the **winning design reduced the bracket weight by 84%, presumably to save on fuel costs**. [685]

9.96. Talent Management Process

Thomas Edison, the founder of General Electric, said, "I find out what the world needs, then I proceed to invent it."

G.E. now files an average of more than five patents per day — 20,000 patents over the last decade.

Susan Peters Vice president, Executive Development, and Chief Learning Officer at General Electric stated that "If managers expect employees to be creative and productive at this level, the company itself must be comfortable with risk. At G.E., our approach to **risk is integrated into our talent management process**: we evaluate employees not only on their accomplishments, but on their ability to reflect the company's guiding principles. These principles are broadly defined as external focus, which involves collaborating with customers, governments, regulators, community groups and others; inclusiveness, which recognizes that humility and diversity are essential to building a great team; clear thinking, which requires agility, decisiveness and strategic commitment; expertise, which indicates both a deep knowledge base and a passion to develop others; and imagination and courage." [686]

9.97. Globalization and Innovation Demands New Type of Leaders

From the incandescent light bulb to the electric washing machine, **General Electric** has been responsible for some life changing inventions. But according to VP of Executive Development And Chief Learning Officer Raghu Krishnamoorthy, the greatest innovation the company has achieved is its leaders.

GE currently has more than 300,000 staff and a presence in more than 171 countries. It is against this global backdrop that GE's leadership development strategy has had to evolve.

Today's business world needs a new type of leader, one **who can deal with globalization**, the **velocity of change** and the **wants and needs of different generations**. "The old paradigm used to be that **competition** builds successful teams; the new paradigm is **collaboration**," Krishnamoorthy explains. "The **old paradigm was command and control**; the new is **connect and inspire**. The old paradigm was be a **boss and govern**; the new is **coach and empower**." [687]

4.98. Few More Ways

In addition to this, there are many issues like

- Help them understand the value of getting to shared vision
- Getting Out of the Comfort Zone
- Comfortable with Ambiguity, Innovation is Fuzzy, its Not Binary.

4.99. Running Innovative Company and Innovation Ecosystem

I would like to quote few points from the article published by Michael Schrage, MIT Sloan School's Center for Digital Business in Harvard Business Review. [186]

Running a truly innovative company means constantly improving your innovation culture and process. **Running a successful innovation ecosystem**, however, **demands more**. Successful innovation ecosystems **make people outside the company measurably smarter, richer, and more innovative**. Biologically speaking, innovation ecosystems invest in symbiosis, not parasitism. Growth isn't zero-sum. While **successful innovators** reap new profits from new products and services, **successful innovation ecosystems** cultivate profitability by **encouraging others to create valuable new offerings**. Their financial futures depend on how innovative they make their customers, clients, channels, and partners. **Truly effective ecosystems manage to turn outsiders into de facto collaborators.** Enabling external innovation becomes as important as improving one's own. In fact, successful innovation ecosystems create virtuous cycles of external creativity, which drives internal adaptation. In turn, internal innovation enables and inspires external investment. [186]

This is the real IP — not "Intellectual Property" but "**Innovation Partnerships**." Look at Amazon Web Services, GitHub, Toyota and YouTube's investments in suppliers, and Apple's App Store. Or consider Netflix's efforts to procure binge-able viewing: With Netflix's new commissions of series like House of Cards and Orange Is the New Black, creative people are now producing for a Netflix audience the way they once did for syndication, cable, and HBO. The common denominator for all these companies isn't simply an exchange of value, but offering new opportunities for collaboration. **Success comes from exploring how to make one's partners more valuable innovators**… why Google acquired Nest and why its **ecosystem is broader and deeper** than Microsoft's or Yahoo's. In other words, **if you're not making your innovation partners richer in some measurable way, you're simply running an innovation factory, not an ecosystem.** [186]

4.100. Innovation Leaders

Not long ago, **strategy was king**. Forecasting, planning, and placing smart bets created the power sources within organizations. The future of a business (or a career) **could fit into an established framework or system**. **If managed well, success would follow**. [11]

Today, uncertainty is palpable. Planning for next quarter is a challenge. Even more difficult is committing to decisions that will play out in one to five years. **What is the new process, the innovative product, the game-changing service, or the compelling vision?** [11]

In today's fast moving and complex global environment, the ability to innovate and deploy faster and more profitably than competitors is now a requisite for growth and success. For companies that are founded on new products, such as Apple, the focus on innovation has always been a fundamental part of the culture. For many companies, the move to dynamic-innovation is more difficult for many reasons which include a diverse customer base, a complex mix of products and services, a focus on minimizing risks and a traditional static-control culture. The burst of focus in the last decade has focused on innovation processes, such as the Stage-Gate, and on the CEO's role in setting a strategic vision and creating organizational structures and processes that unleash creativity, risk-taking, and collaboration throughout the organizational culture. **Very little has been written on Innovation Leaders**, those individuals who lead a new product or service through ideation, design, development, market launch and implementation. **These Innovation Leaders will be the catalyst for change by bringing diverse parts of the organization together to launch new products and services**. Our research focuses on the Innovation Leader, specifically:

- What are the distinguishing characteristics or capabilities of a successful Innovation Leader?
- What practices do Innovation Leaders follow to enhance their success and conversely, what practices tend to detract from the success of these leaders?
- What organizational practices support and detract from successful innovation?
- How to select and develop individuals who will be successful? [11]

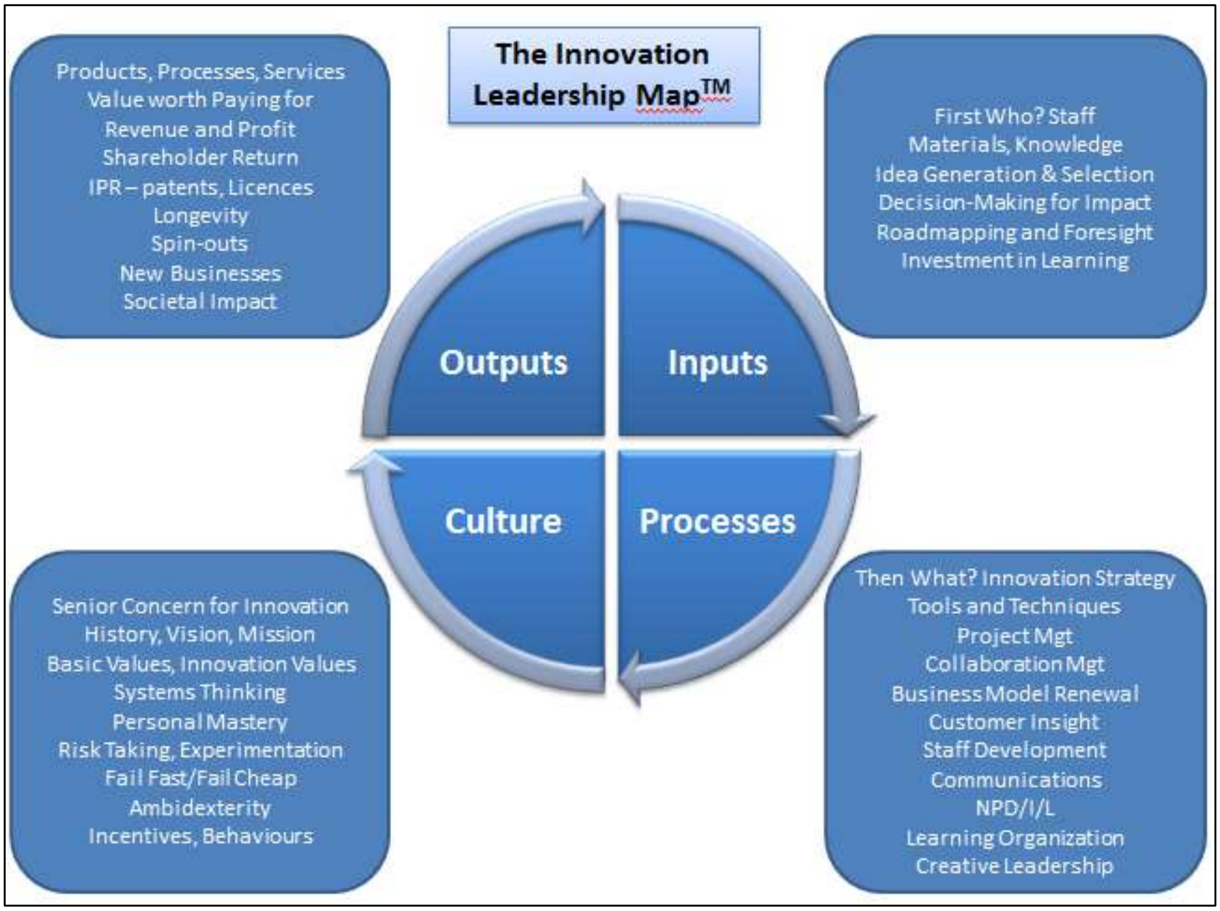


Fig. 4.13: Innovation Leadership Map [636]

The leaders of companies on this year's BusinessWeek-BCG list of the World's **Most Innovative Companies** recognize that developing breakthrough products, revamping operational processes, and coming up with new business models **doesn't happen overnight**. Instead of relying on gimmicks or incremental line extensions, **they're working to build organizations that are capable of sustained innovation**. They understand that requires taking risks and investing for the long term. And they focus on the things that really matter, such as hiring the most talented employees and providing them with the environment they need to thrive… "If you want an innovative environment, hire innovative people, listen to them tell you what they want, and do it." [666]

Chapter 5: Innovation Culture Eats R&D for Breakfast

"Culture eats strategy for breakfast" - Management guru Peter Drucker [56]

5.1. Alarming Confusion: Research & Innovation

The crisis that has befallen the Spanish economy has highlighted the importance of a change in the economic model, from a bricks' based economy into an innovation economy. To make this change possible, Spanish companies have to get rid of the barriers that inhibit innovation, and for this it is important to start with the **right definition of what we mean by innovation in the business world**. Whenever you read a newspaper article on the topic of innovation or you hear someone in government talk about what is being done to encourage innovation, it seems that **they speak only of "R&D" or "scientific research" as a synonym of innovation**. This is an **alarming confusion**. [344]

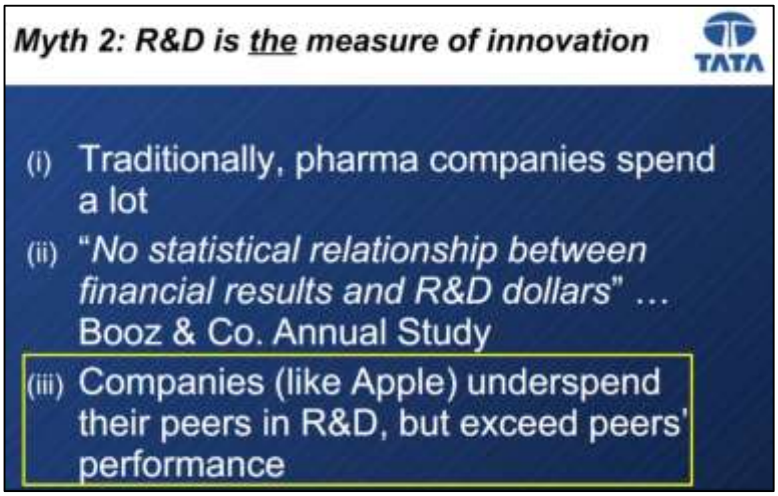


Fig. 5.1: Presentation by R. Gopalakrishnan, Director Tata Sons: Myth - R&D is the measure of Innovation [413]

Bill George, Professor, Harvard Business School stated that "Research and Product Development Are Not Innovation. In this era, many companies are investing heavily in research and product development, yet they fail to create innovative products and ideas. U.S. pharmaceutical companies like Pfizer and software companies like Microsoft illustrate that **heavy spending on research and product development doesn't necessarily yield innovations**. In contrast, the breakthrough ideas that created Genentech, Google, and FaceBook illustrate what can be done with **limited budgets**. It is important to recognize that research, product development, and innovation are radically different disciplines. **Research is based on** well-established scientific principles. At its best, research produces scientific breakthroughs that extend knowledge like Schottky's invention of the transistor and Novartis's breakthrough drug Gleevec for treating chronic myelogenous leukemia. **Product development**, on the other hand, follows established engineering principles to improve existing products. **Innovations result from** unique ways of looking at problems that produce original solutions. Another approach to innovation takes existing ideas and combines them into unique solutions. In retrospect, the outcome may seem obvious, yet is highly original. Apple's iPad is an example, combining Apple's iPod, iPhone, and iMac to create a breakthrough product." [646]

As long as innovation is viewed in such a limited way, it will be **difficult to design and implement the right measures capable of addressing the real problem that inhibits innovation in companies**. Some time ago, and to refute the hypothesis that firms that invest the most in "R & D" are the most successful and innovative, we turned to an article published in the journal "strategy + business" (n º 53). The article listed the 20 global companies that had invested the most in R & D during 2007. Interestingly, the first thing we may noticed is that only 7 of these companies were also among the top 30 of the most innovative companies list compiled by Business Week. But even more interesting was the analysis on the performance of the companies included on both lists over recent years… Also, limiting the study to the last 10 or 5 years, the difference becomes more drastic. Between 1997 and 2007, the most innovative companies evolved **10.56 times** the S&P 500, while those that invest the most in R&D did just **1.63 times** better! …This reveals three key issues that companies and government officials should bear in mind given the profound implications for companies and countries' economies: [344]

1. A greater investment in R&D, over long periods of time, help firms perform significantly better than the market average.
2. However, the mere fact of investing in R&D does not necessarily make companies more innovative (and therefore capable of commanding higher valuations). Companies can innovate without necessarily investing heavily in R&D.
3. **When the focus changes and companies invest in innovation, rather than just in R&D, the results are much more powerful than those obtained from investing only in R&D**.

Therefore, companies need not wait for government policies to become more innovative. All they have to do to innovate can be done with the resources they already have. First, they must start with the correct definition of innovation, which is much broader than just "R&D" or "scientific research". [344]

Fig. 5.2: Innovation: New definition [344]

The words Innovation and Research are used in the same context in the public sector but not, necessarily in the private. Research is the exploration into the unknown where outcomes are not necessarily defined and unsure. Innovation is the APPLICATION of Research (specifically the commercial application which maybe for personal profit or the wider good). This differential could also describe the difference between the public and private sector too. Universities are centres of excellence for Research but we would argue that **Universities are not great Innovators**. **Innovation comes from the private sector who understands the commercial opportunity of research**; this was the basis of the debate. Without wanting to be too political, it is the private sector that creates the wealth of a nation through the commercial exploitation of research, wealth which includes the highly skilled jobs the Government is keen to see created. Unfortunately, though, because **the public sector misunderstands the difference between Research and Innovation, the boundaries between the role of a University and the private sector get fuzzy**. [343]

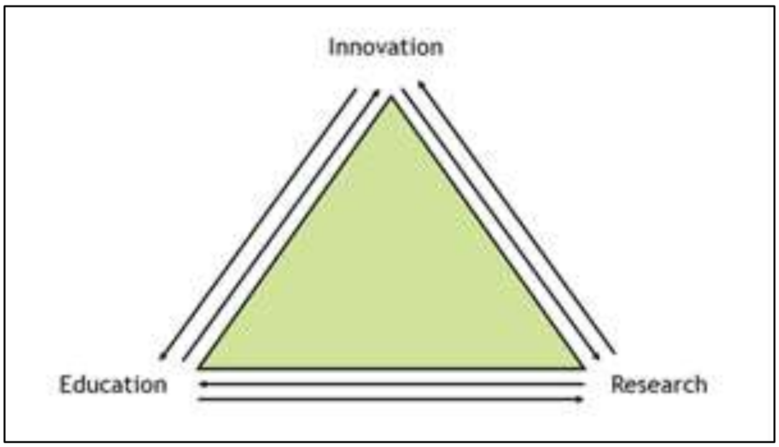


Fig. 5.3: Relation of Education, Innovation and Research [28]

The Manufacturing Performance Survey (June 2005) of Fraunhofer Institute for Systems and Innovation Research, **Germany** namely "**Innovation: More than Research and Development**" stated that "**Neither** innovation business models **nor** the realization of innovative organizational solutions **nor** the implementation of innovative process technologies **originated from the research laboratories of the companies**…A **one dimensional understanding** of innovation as research based development of high-tech products does probably **not meet the demands of the variety of economically promising innovation strategies**. Alternative innovation paths and their rational combination may very well provide a basis for international competitiveness. The Broader understanding of Innovation is necessary, which is shown by following diagram. [345]

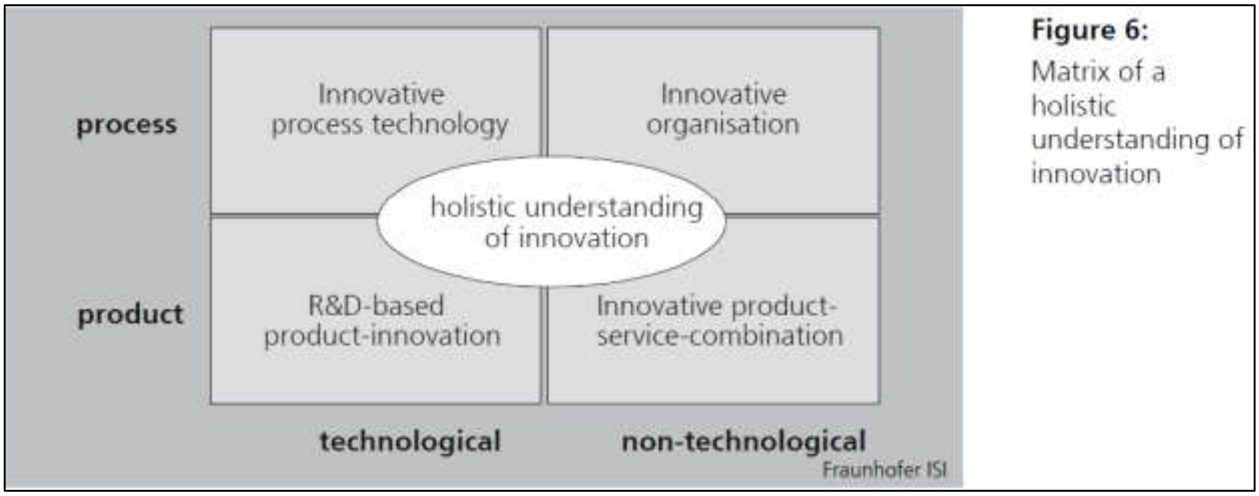


Fig. 5.4: Manufacturing Performance Survey of Germany: Holistic Understanding of Innovation [345]

The trap that I fell into all those years ago was **thinking about innovation as a linear process**, with scientific progress being the fountain for all innovations. The origins of this thinking go back to the 1950s and despite the evidence that innovation goes a long way beyond the commercialization of discoveries, we are still left with pockets of this intellectual legacy. However, **thinking is now changing quickly**. Hard times call for new solutions and we are starting to take a good hard look at **how innovation really works** and what we can do to improve performance. Recent reports from the **OECD on national innovation strategy represent a big shift from the old linear models** that start with R&D and end in successful products. One of the major points from a study of innovation indicators is that the **measurement of R&D is a poor indicator of innovation**. Even in **Australia where there are tax benefits for R&D spend, the product innovation difference between firms that report R&D and those that don't is minimal**…The same is true for Norway and Mexico. Although there is a general trend of firms conducting R&D being more likely to report new-to-market innovations, there are still a lot of firms that **don't officially do R&D that are innovative**… OECD surveys show that many firms are getting their most significant ideas for innovative products, services and processes **from outside the business**. These can be customers, suppliers, competitors, consultants or universities. [346]

Instead of thinking about innovation as a chain were an idea gets developed from inside the firm and commercialized, the modern reality of innovation is that it is a knowledge ecosystem where **innovations come about through new connections** within and between organizations. I'm not saying that **science and research** aren't important – they are. However, rather than the being the origin of innovations, they are **part of the system**. The old thinking on innovation was to pump in more science at the front end to get more innovations. The new paradigm is all about connections. [346]

EIT ICT Labs is one of the first Knowledge and Innovation Communities set up by the European Institute of Innovation and Technology, as an initiative of the **European Union**. The article by Dr. Roberto Saracco, President and Node Director of European Institute for Innovation and

Technology (EIT) Italy at this blog stated that "I think that there is a **gross misunderstanding on the drawing linking research to innovation**. And it is a **misunderstanding at several levels**… Research is a lever that provided with money will generate knowledge whilst innovation is a lever that provided with knowledge will generate money, as exemplified in the sketch I drew… I explicitly drew little green men carrying out research and little red men carrying out innovation to highlight immediately that they are different from one another. They have different skills, different motivation, and they operate in different environment. That is why I drew them "outside" of the loop, and not inside. Now, don't take me wrong, you might run into a little red man that dresses up in green to do research so that he gets what he needs to innovate, and I met a few of them in my professional life. But on the average they are exception and they will not accept to disguise themselves as green men for long. On the other hand, I still have to meet a real green man disguising himself as a red man.

- A green man, a researcher, is doing his activity for the pleasure of understanding technology, science, and to create knowledge. If you ask him: "what's that for" he is likely to shrug, saying that you never know, something that might seem useless today may have a tremendous impact tomorrow (you might remember JJ Thomson's, the discoverer of the electron, favorite toast: "To the electron -- may it never be of any use to anybody." But, most importantly, he is not interested in pursuing that impact. Having his paper presented at a major conference or published by a leading journal is all it takes to make him happy. He is willing to accept as result of his research nothing but the best.
- On the other hand a red (wo) man is focusing on hitting the market and making money. If that money comes because she is first to (understand) the market or because her product cut costs, or is something really new doesn't really make a difference. Now don't take me wrong. Innovators are proud of their baby, as researchers are proud of theirs. But they look at different aspects to be proud of.

They are both aiming at re-shaping the future that goal is the same, but they belong to two different worlds." [348]

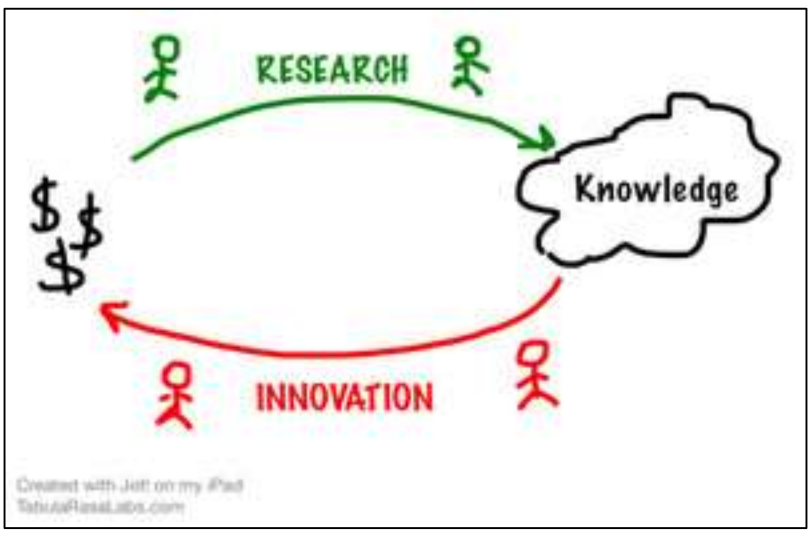


Fig. 5.5: Research & Innovation: Two different worlds [348]

Harold L. Sirkin, Senior Partner of The Boston Consulting Group (BCG), Professor at Northwestern University's Kellogg School of Management stated that "Many people—including a lot of senior executives I've talked to—**think** innovation is primarily a research and development function. **But** innovation should be understood to include the entire value chain: from R&D to engineering, manufacturing, distribution, sales, marketing, and even facility utilization and investment strategy." [349]

Jeff Dyer, Professor of Strategy at both Brigham Young University and at the Wharton School, University of Pennsylvania and Hal Gregersen, Abu Dhabi Commercial Bank Chaired Professor of Innovation and Leadership at INSEAD stated that "In rejecting the **limiting belief** that innovation is R&D's job alone, leaders of highly innovative companies work hard to instill "innovation is everyone's job" as a guiding organizational mission." [350]

Hutch Carpenter, Strategic Consultant with HYPE Innovation, in his article "**Innovation Culture Eats R&D for Breakfast**", stated that "Booz & Company tackles this issue head-on in its just-released annual report on the Global Innovation 1000, titled "Why Culture Is Key". Booz analyzed the R&D spend of 1,000 companies. That provides a "classic" view of which firms are investing in innovation. The researchers then asked survey participants to identify the companies that are demonstrating the most innovation in the market. The results are eye-opening. There **is no statistically correlation between R&D spend and innovation.** There is no statistically significant relationship between financial performance and innovation spending, in terms of either total R&D dollars or R&D as a percentage of revenues." [351]

R&D doesn't buy innovation

Innovation Rank	Company	2010 R&D Dollars ($B)	R&D Ranking
1	Apple	$1.78	70
2	Google	$3.76	34
3	3M	$1.43	86
4	GE	$3.94	32
5	Microsoft	$8.71	4

Source: Booz & Co., 2011

Fig. 5.6: Comparison of R&D Ranking and Innovation Ranking: Top Innovators, Lower R&D Spend [351]

The research report (38 pages) from Anthony Arundel and team from United Nations University UNU-MERIT, Netherlands stated that "**R&D is not the only method of innovating**. Other methods include technology adoption, incremental changes, imitation, and combining existing knowledge in new ways. With the possible exception of technology adoption, all of these methods require creative effort on the part of the firm's employees and consequently will develop the firm's in-house innovative capabilities. These capabilities are likely to lead to productivity improvements, improved competitiveness, and to new or improved products and processes that could be adopted by other firms. For these reasons, the activities of firms that innovate without performing R&D are of interest to policy." [352]

- The Innobarometer (IB) 2007 survey is based on a quota survey for all 27 EU member states. Results are available for **4,395 innovative firms**, covering innovative activities over 2005 and 2006. Of these, **52.5% innovate without performing R&D (non-R&D innovators)**, 40.0% perform R&D in-house, and 7.5% contract out R&D to other firms or organizations.
- The **share of non-R&D innovators is similar to the 50% share** observed for the third **European Community Innovation Survey (CIS)** for the three year period of 1998 to 2000. [352]

5.2. Remember That They Are Different, Don't Confused

- Innovative Teaching methods and Teach techniques to Innovate
- Innovative curriculum and Curriculum to develop innovative workforce
- Innovative Pedagogy and Pedagogy for developing innovative manpower
- Innovative Research Programs and Use of research to bring innovation
- Research collaboration and Collaboration for Innovation
- Entrepreneurship and Entrepreneurship to develop Innovation in company
- Teaching Creativity and Teaching Innovation
- Teaching Research Techniques and Teaching Innovation Techniques
- Building Research Culture and Building Innovation Culture
- National Innovation Ecosystem and University Innovation Ecosystem
- Investment for R&D and Investment for Accelerating Innovation
- Research and Patents vs. Innovation and Patents
- Discovery / Invention and Innovation
- Research Mindset and Innovative Mindset

Chapter 6: Innovation: Role of University

*"…because the public sector **misunderstands the difference between Research and Innovation**, the **boundaries between the role of a University and the private sector get fuzzy**." [343]*

*Building Culture of Innovation for **producing Innovation** (Product, Process, System, Business Model) and for **developing Innovative Brains** are altogether different processes. To understand these two "culture building processes" one should have clear idea of role of Industry and University in innovation process.*

*The Main Job of University or Higher Education Institute is to Produce Highly Employable **Innovative Brains**. The other role of the University are Research, Innovation, Circulation of Knowledge and Technology Transfer. Mostly the innovation happens at the point of production or manufacturing, which is not the job of University. Thus it is expected that for Innovation the University should play a supportive role to the industry. The **Innovation Management** is the costly process and it is not expected that the University should participate in this process.*

*"In the 21st century world-class universities will need to be much more focused on innovation, rather than on stability and standardization… Those who want to **create and maintain a world class university will need to develop a culture of innovation in their organizations**… Universities that are **able to build a culture of innovation are more likely to develop and maintain world class status** than those institutions that use the past as a guide to the future…" William G. Tierney, Professor. Co-Director, University of Southern California, USA [1]*

*Innovation requires nothing short of a **paradigm shift in the established ways of thinking about university education**. It calls for Redefinition of knowledge and its purpose, Reorganization of branches of knowledge, Rethinking the existing practices of teaching-learning and research and Recognition of the limits of what we know [45] [46]*

*Universities can not only be part of the new regional innovation ecosystems; they have the full capacity to evolve as a **kind of 'cement'** to reinforce such ecosystems. [641]*

6.1. Role of University & HEI in Innovation: Different Views

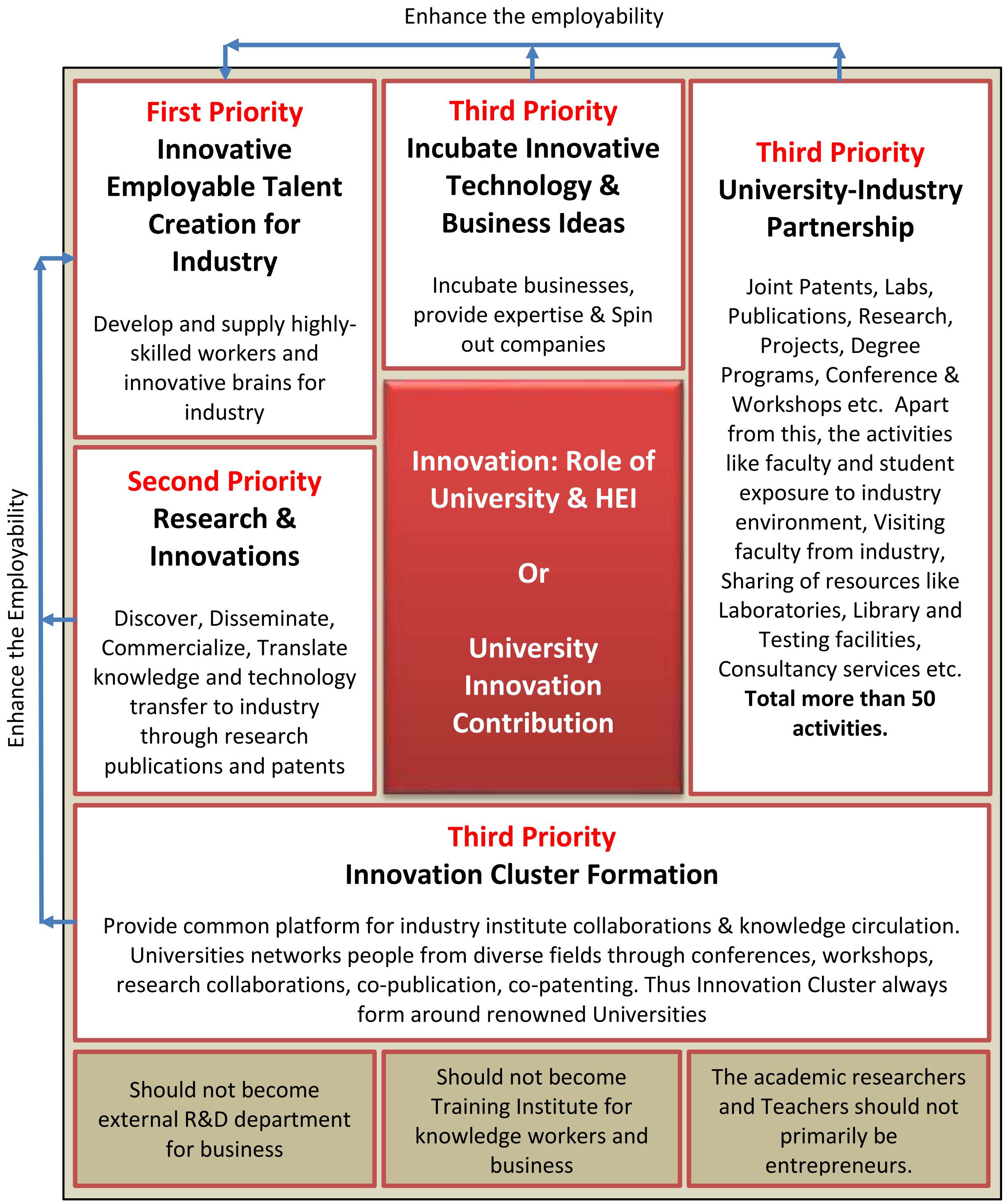


Fig. 6.1: Innovation: Role of University or Higher Education Institutes (HEI)

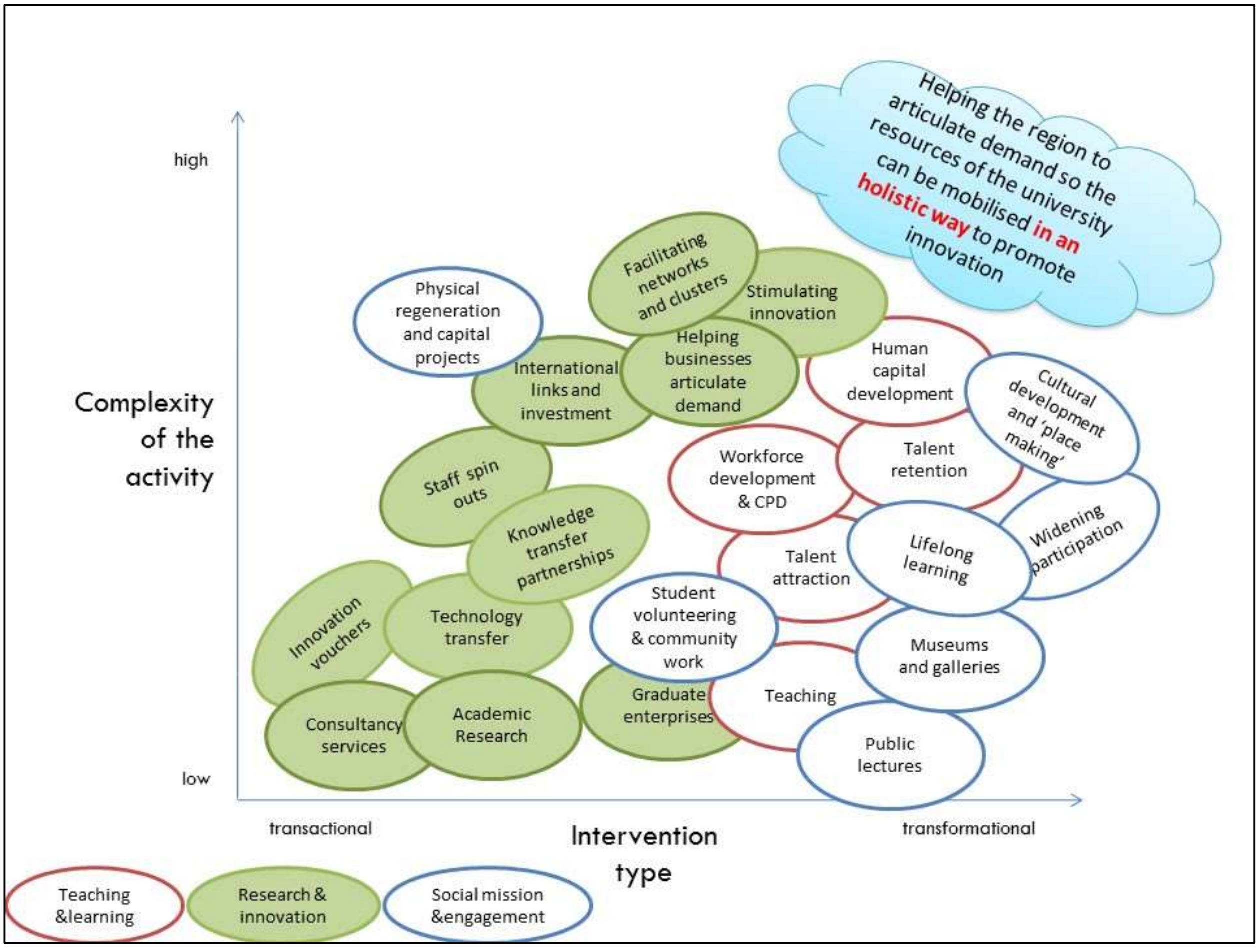


Fig. 6.2: Role of University to Promote Innovation (Green oval shapes) [293]

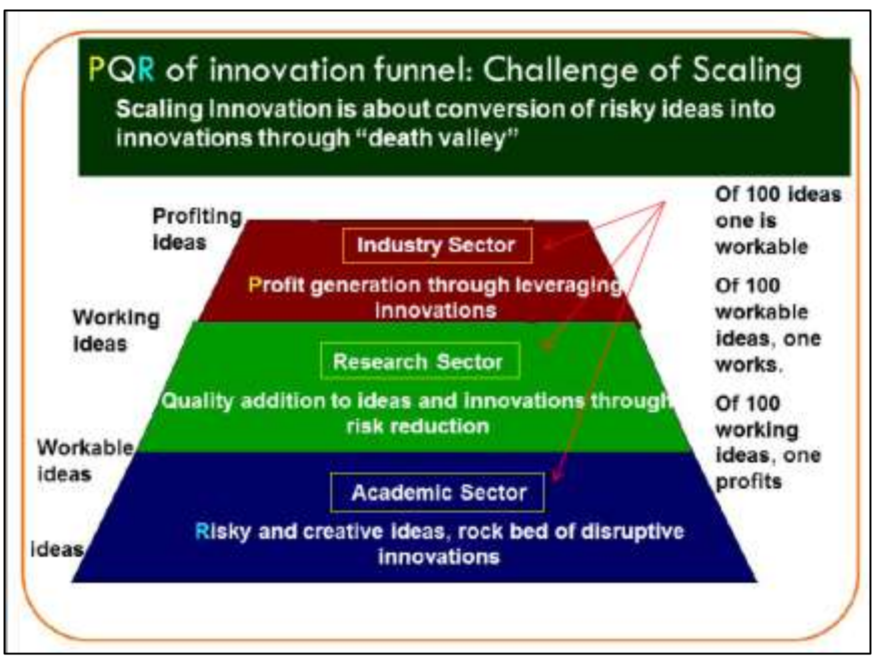


Fig. 6.3: Role of Academic, Research and Industry sector in the process of Innovation [220]

The above figure clearly shows the role of Academic sector, Research sector and Industry sector in the process of Innovation.

The report of the Group of Eight (Go8), Coalition of Leading Australian Universities stated that **"Universities make a broad-based contribution to innovation** and to the resilience, strength and reputation of the national innovation system, the value of which is difficult to estimate…An **overall conclusion is that what business most needs from universities is a ready supply of competent, talented and creative people able to apply their skills and further develop their potential across the whole range of business activities**. [294]

There are **many ways in which universities disseminate knowledge to participants in other parts of the innovation system.** One is through the training they provide to their students but other formal and informal mechanisms are just as important.

- Preparing text books and critical reviews,
- Publishing in the formal and other literature,
- Acting as public intellectuals by providing press commentary, radio or TV interviews,
- Speaking at conferences, attending trade fairs

and many other mechanisms all add to knowledge diffusion. Given the complexity of the innovation system and the importance of informal linkages within the system, it is important not to discount these considerable contributions to innovation while continuing to recognize the importance of

- Consultancy,
- Secondments,
- Licensing,
- Spinoffs

and the other mechanisms that usually form the focus of innovation studies. [294]

The report of the Group of Eight (Go8), Coalition of Leading Australian Universities stated that **"Universities do not usually commercialize technology themselves – they transfer it to another organization to commercialize**. In some cases this might be a spin-off company but this approach tends to be high risk compared to licensing technology to businesses that already have the capabilities necessary to use and commercialize the technology and which have existing distribution networks and other infrastructure that they can draw upon. **Universities do not form complete innovation systems in themselves** but feed into and draw upon institutions that have complementary capabilities, information and market links." [294]

The Internet, one of the greatest innovations of the 20th century, came out of the U.S. government's Defense Advanced Research Projects Agency (DARPA) and MIT's Lincoln Lab, way back in the 1960s. But the notion of global interconnected networks did not reach commercial maturity until the mid-1990s, when the Web browser came into existence. The 30-year research and development period would not have been sustainable without the enormous DARPA funding that stimulated much of the U.S.-led innovation over the last four decades of the previous century. Such a gestation period is simply not viable without government funding and commitment, and without the **framework of universities and research labs being the incubators for fundamental innovation**. [2]

The traditional role of universities were education and basic research. In the past 2-3 decades new functions were taken over:

- Knowledge and technology transfer to industry
- Commercialization of knowledge
- More active role in national and regional innovation systems. [4]

It is clear that the role of universities in innovation is more subtle than government policies have acknowledged.

- Universities that are active at the heart of successful technology clusters do not just **spin out companies**
- Universities **develop highly-skilled people** who move between industry and academia
- Universities **incubate businesses and provide expertise**
- Universities **produce knowledge** that is used by technology businesses
- Universities **provide public space** in which people from various overlapping branches of research meet. Some universities in the UK perform these functions successfully. [3]

Role of universities in innovation systems and clusters of knowledge based industries

- "Antenna" for adopting external knowledge and mediator for local knowledge circulation
- Source of highly qualified labor
- Knowledge provider in university-industry linkages, and
- Incubator for academic spin-off companies [4]

The role of universities in innovation systems and clusters is to **bring in critical views, new ideas, and knowledge**; not only just carrying out R&D for industry. Universities hold a key function in this respect being inserted in global knowledge communities and **networks through** conferences, workshops, research collaborations, co-publication, co-patenting etc. [4]

Fig. 6.4: University has 3 options for Commercialize the knowledge [5]

The university is increasingly seen as an engine of regional economic development. Since the 1980s the university's role has been framed in terms of its contribution to **industrial innovation**. The conventional wisdom views this contribution as occurring primarily through the **technology**

transfer model. The university, in this way of thinking, must move closer to industry and the marketplace by translating research into deliverables for commercialization. [6]

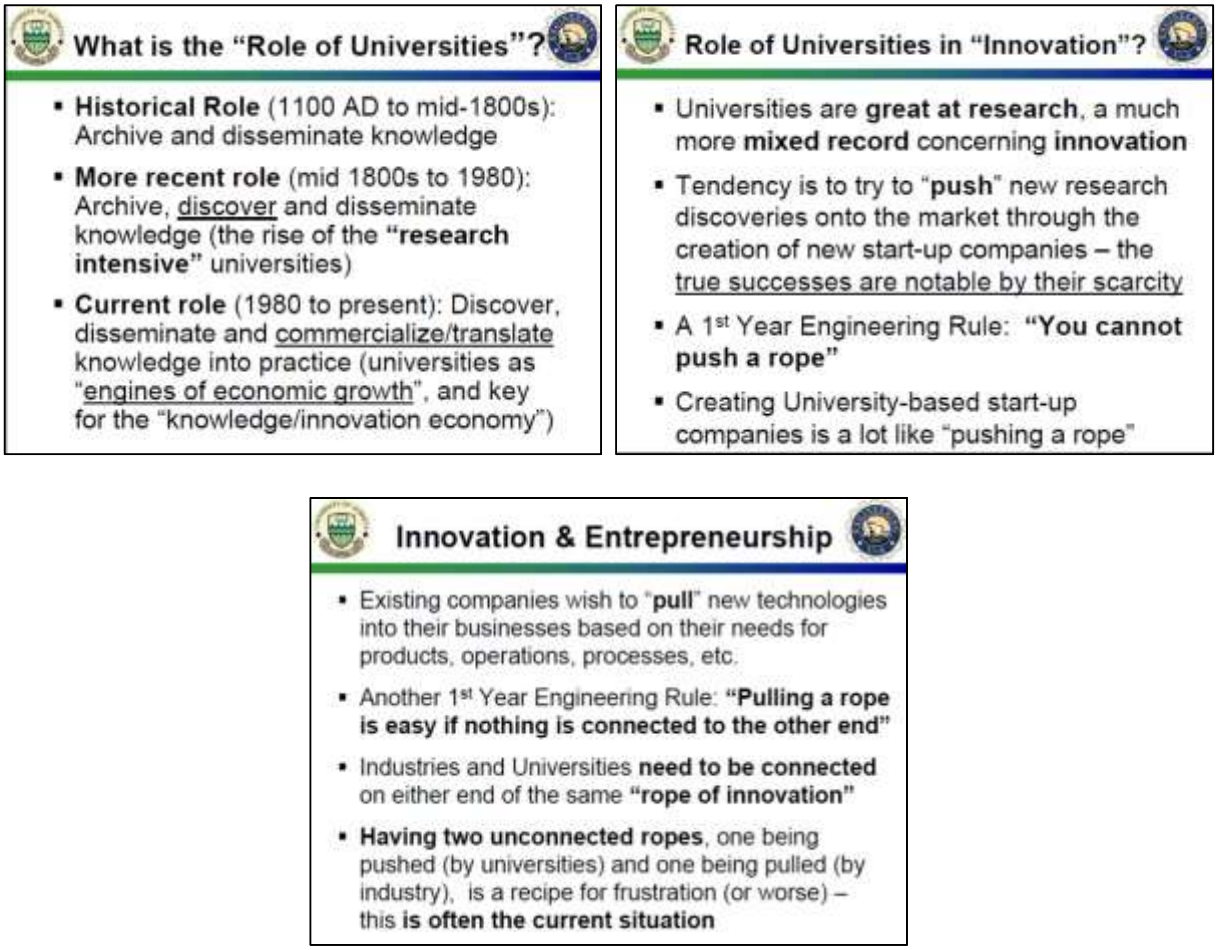


Fig. 6.5: What should be policy of University for Innovation? [7]

Three main pillars can be distinguished when considering the establishment of an innovation culture in universities:

- The first pillar dealing with skills, education and training for innovation
- The second one focusing on innovation in research and knowledge transfer
- The third one providing an innovation supporting infrastructural environment. [37]

Academic entrepreneurship is more than a technology transfer process. It is a shift in academic culture that adds another dimension to higher education.

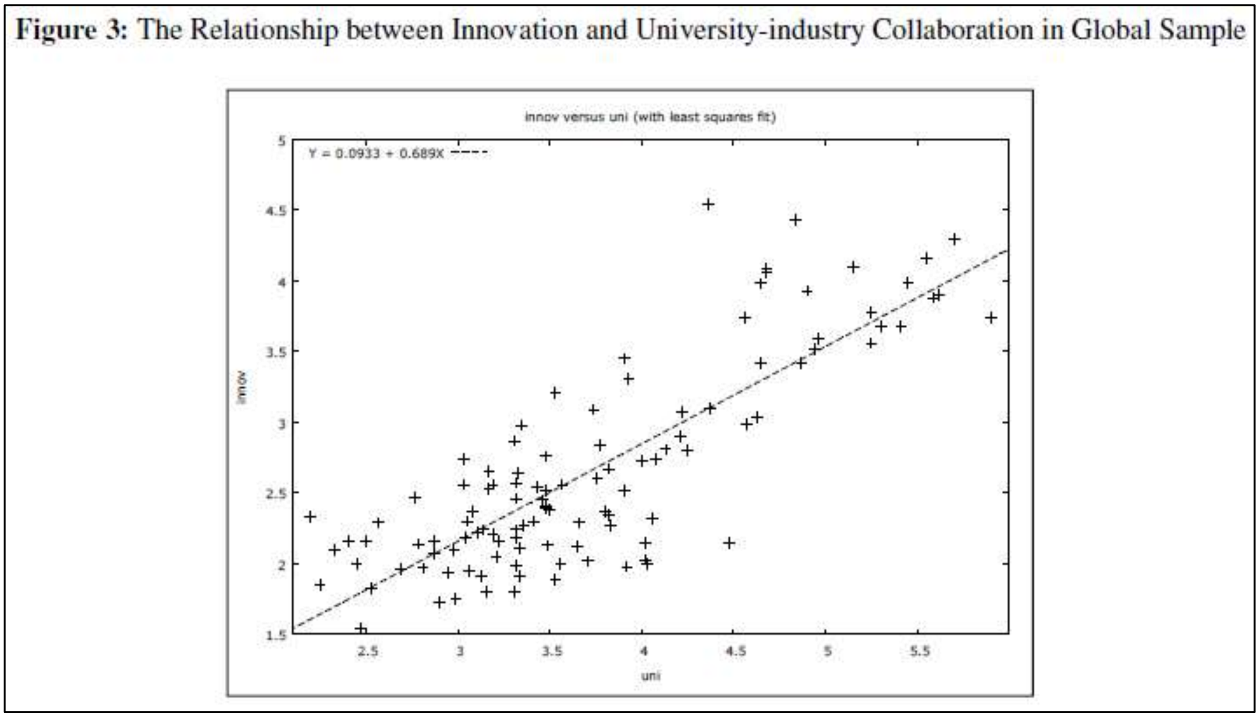


Fig. 6.6: Regression Analysis of Global Innovation Index data: Innovation & University-Industry relationship [254]

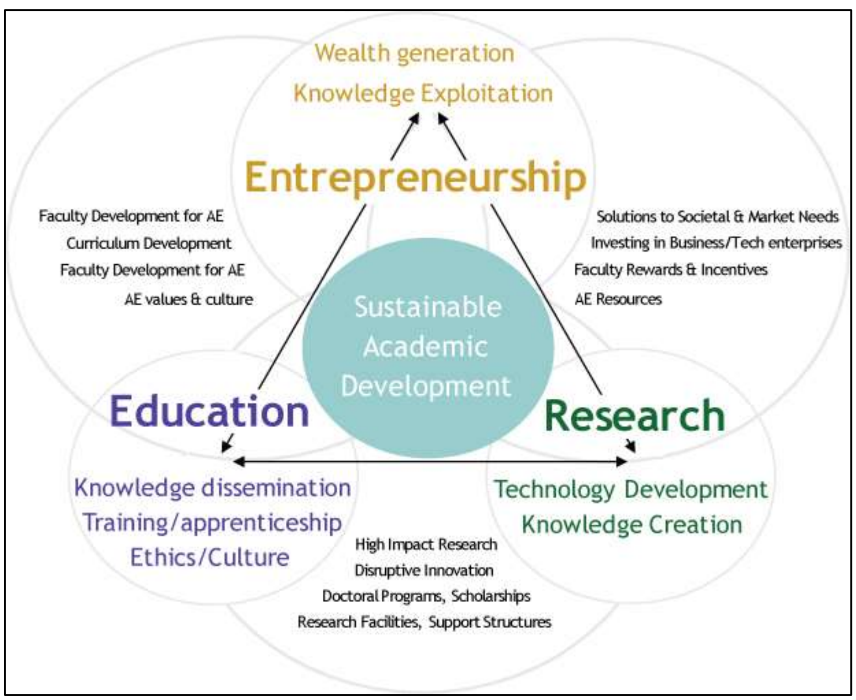


Fig. 6.7: The Academic Triangle: Evolution of University Roles [25]

The presentation of J L Barnett, Nelson Mandela Metropolitan University highlights the role and relationship of University and Industry related to Innovation. [72]

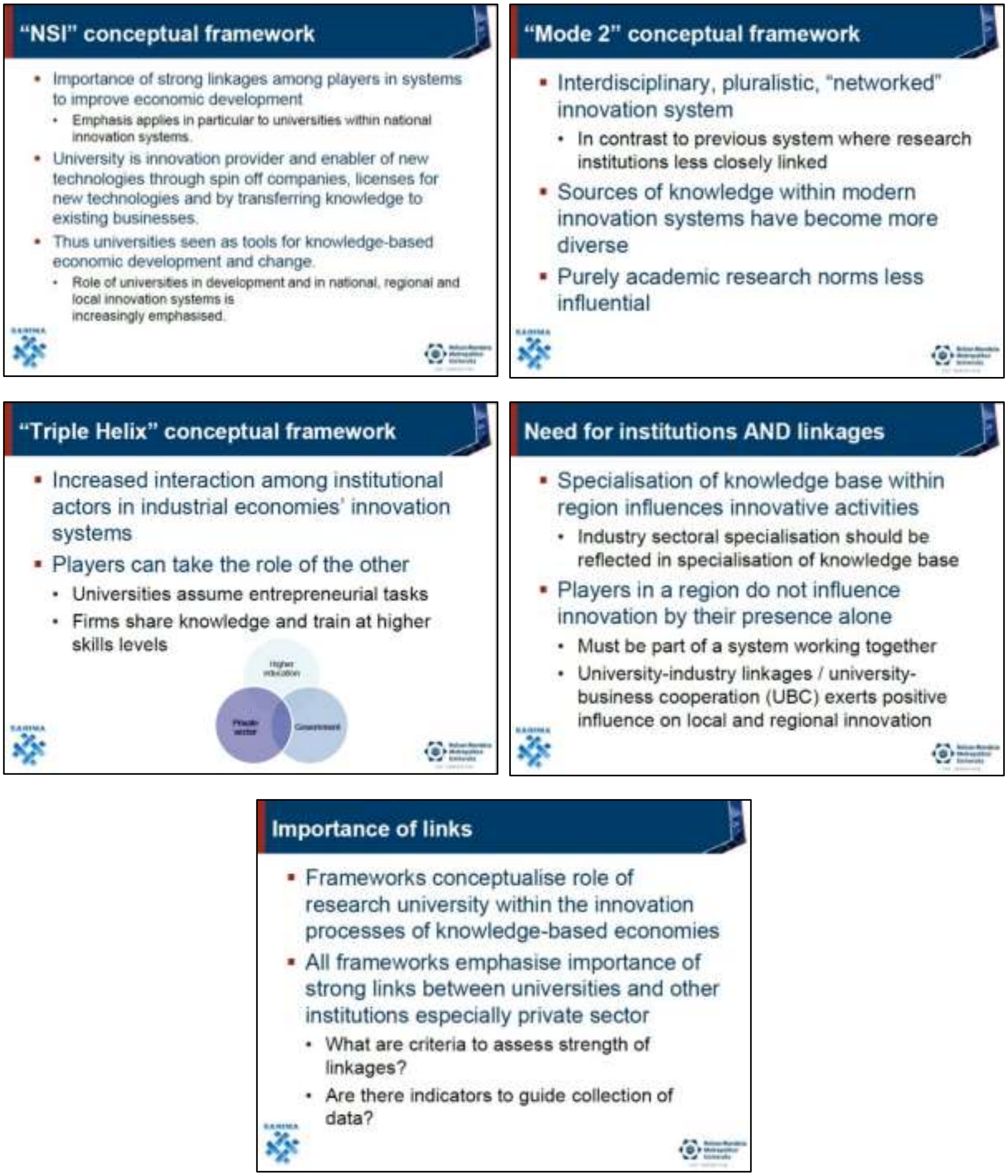


Fig. 6.8: Paradigm Shift: Role of University and Industry [72]

In the 21st century **world-class universities** will need to be **much more focused on innovation**, rather than on stability and standardization. An innovative organization is different from a stable one. It requires different skills from its participants, and it functions in a different way from a stable organization. A focus on innovation will necessitate a different kind of university from what exists at most institutions today. Those who want **to create and maintain a world class university will need to develop a culture of innovation in their organizations**. [1]

With this constant state of flux in the academic world, the institutions that are most successful are those which are able to manage change and innovation. **Those who adhere to a principle of "staying the course" are likely to run aground**, due to the rapidly changing conditions of the larger environment. The challenge is to neither accept that a university must maintain the status quo nor assume that only entirely new universities will succeed. [1]

I have suggested here that, in order to assume the mantle of a World Class University in the 21st century, institutions need a different type of organization from what most of them have become. Academic cultures are based on traditions that may have been centuries in the making. Even relatively new universities function in a world where the model of excellence has been on building on traditions and improving the organization by way of what I have called "sustainable technologies." The **21st century**, however, requires universities to develop a **culture of innovation**. I have argued that innovation does not just automatically occur; instead it needs to be built into the culture of the organization. Barriers exist that need to be overcome, and an organization's leaders need to think about ways to create processes and procedures that reward risk taking. The aim of an organization is to build collaborative environments based on stable goals where individuals have the autonomy to pursue experiments that ultimately will improve the organization. **Universities that are able to build a culture of innovation are more likely to develop and maintain world class status** than those institutions that use the past as a guide to the future. [1]

Let's see the website screenshots of few renowned universities of the world.

Fig. 6.9: Georgia Tech: Weightage to "Innovation" [190]

Fig. 6.10: University of UTAH, USA: Innovation Ecosystem [189]

Fig. 6.11: Innovation: Harvard University & Maryland University USA [10] [20]

Fig. 6.12: Innovation: Purdue University & Boston University

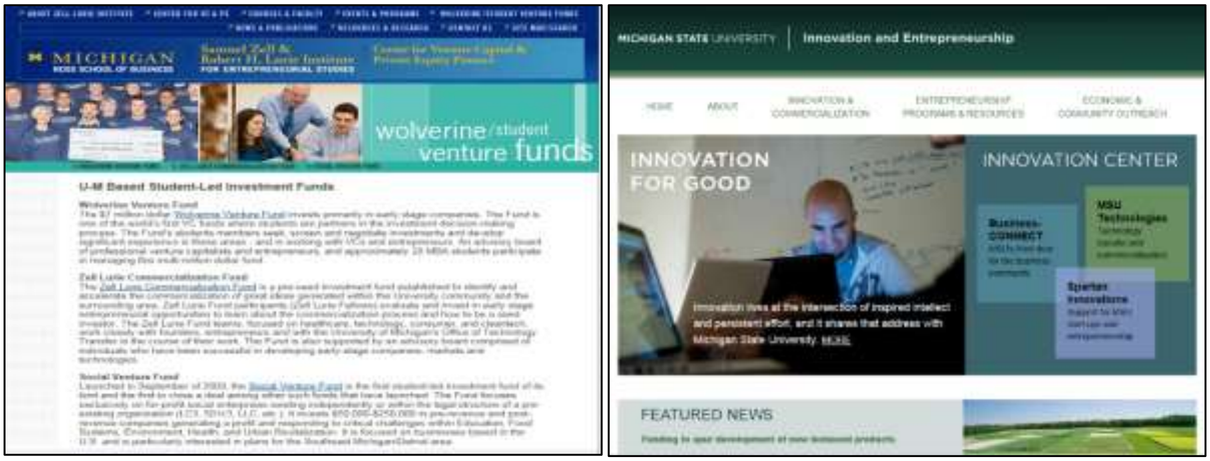


Fig. 6.13: Innovation: Michigan University & Michigan State University [61]

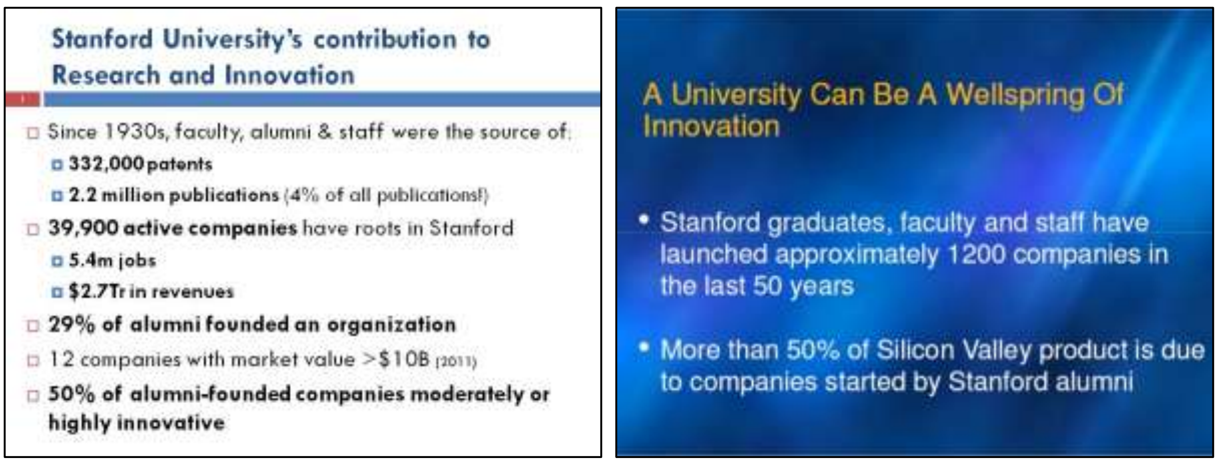


Fig. 6.14: Stanford University: Contribution to Research & Innovation (by Technology Transfer and Start-Up) [21] [206]

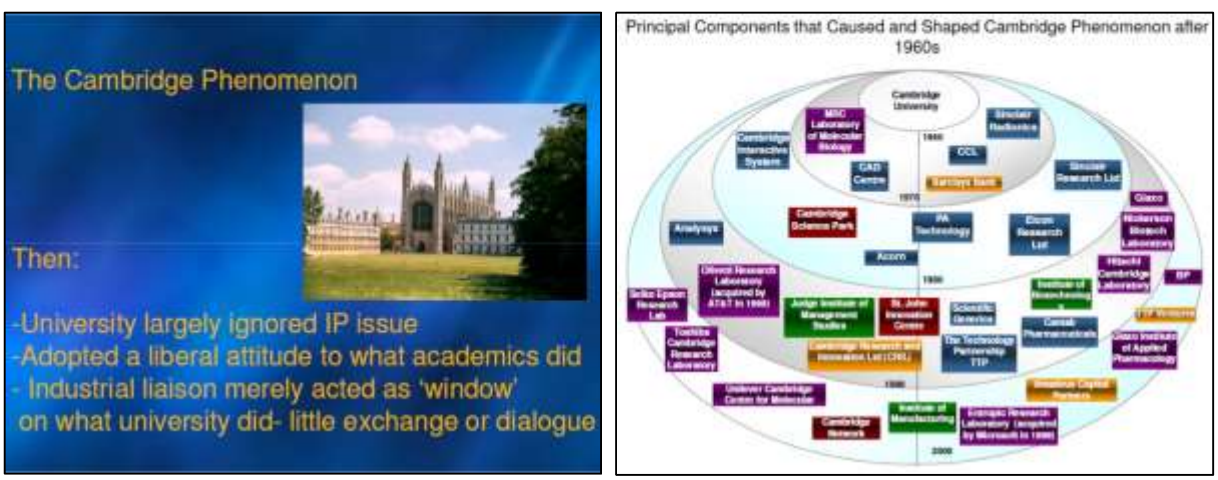


Fig. 6.15: Cambridge University: Before 1960 & Till year 2000 [206]

The Centre for Leadership, Innovation, and Change (CLIC) ISB Hyderabad was established in 2008 with a vision to build transformational leaders for an innovation nation, in alignment with ISB's vision of grooming future leaders for India and the world. CLIC addresses two critical areas of national interest - innovation and leadership. With unstinting support of Biocon, CLIC consists of a dedicated research cell named the Biocon Cell for Innovation Management (BCIM) that develops and disseminates ideas and best practices in affordable innovation, breakthrough innovation, and collaborative innovation. The centre actively contributes to pedagogy through case studies that promote understanding of the innovation process and the associated challenges along with the role of leadership in companies. [505]

Fig. 6.16: ISB Hyderabad: Center for Leadership, Innovation, and Change [505]

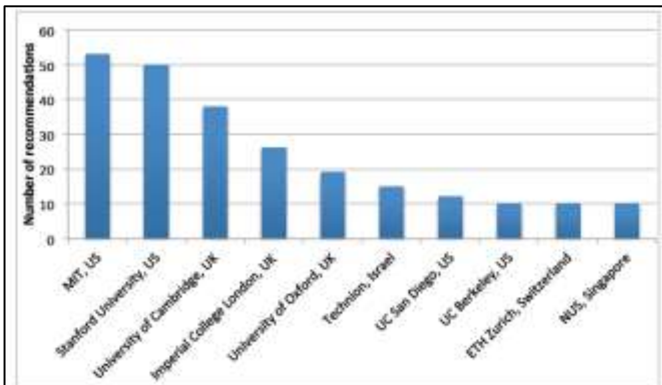


Figure 3. Top 10 responses to the question *'which universities would you identify as having created/supported the world's most successful technology innovation ecosystems'*

Fig. 1.17: MIT Skoltech Initiative: **University Technology Innovation Ecosystem** Benchmarking Study [188]

Most of the universities of the developed countries had started various innovation centers apart from incubation center. Few of them had combined these activities. The job of incubation center is to incubate new companies whereas as it is expected that the innovation center should promote, encourage and nurture the innovative concepts, ideas and projects for the university, government, nation, society and rest of the world.

Faculty innovation center	Agricultural Technology Innovation Center
Business innovation center	Agricultural Innovation Center
Research innovation center	Sensor and Imaging Innovation Centre
Medical innovation center	Photonics Innovation Centre
Technology innovation center	Sales Innovation Center
Food innovation center	Simulation Innovation Center
Social innovation center	Regional Economic Innovation Center
Information Technology innovation center	Jewelry Industry Innovation Centre
Global e-health innovation center	Transport Innovation Centre
Science innovation center	Bioengineering Innovation Centre
Community innovation center	Biomedical Informatics Innovation Center
Rural Technology innovation center	Environmental Innovation Center
Advance Technology innovation center	Center on Organizational Innovation
Process Excellence & Innovation Centre	Innovation Center for Drug Discovery
Education innovation center	Center for Digital Health Innovation
Engineering Product innovation center	Center for 3D Innovation
Law Enforcement Innovation Center	Robotics Innovation Center
Energy Innovation Center	Medical Device Innovation Center
National Polymer Innovation Center	Financial Service Innovation Centre

Table. 6.1: List of Type of Innovation Centers of various universities throughout world

“University research parks are having a major impact on their communities – by creating high-wage jobs…Startup companies are the real job creators in a community…That’s why research parks are so effective - they help launch new companies and create high-wage jobs by giving entrepreneurs and researchers access to business training, a qualified workforce and access to the university faculty and students.” said Kevin Byrne, AURP President and the Chief Operating Officer of the University Financing Foundation.

One example of this is the Purdue Research Park Network. According to a recent economic impact study, the park network is responsible for a $1.3 billion annual impact for the State of Indiana and “more than 4,000 high-tech, high-quality jobs paying an average annual salary of $63,000 – 65 percent higher than the Indiana average.” [8]

North Dakota State University Research & Technology Park generates $10.9 million annually for local and state governments. And according to a recent economic impact study, the 19 businesses located at the RTP account for 893 direct, on-site jobs and another 551 indirect, off-site jobs. [8]

The University City Science Center in Philadelphia has done just that. The Science Center's supportive capacity has helped to leverage Greater Philadelphia's world-renowned cluster of university and research institutions, spurring technology-based regional economic development. According to an economic impact study, the organizations that have originated at, passed through, and received mentorship from the Science Center have created tens of thousands of jobs, hundreds of millions in earnings, and billions in output for the regional economy. Of the 350-plus graduate organizations referenced in this study, the 93 that remain in the region employ 15,512 people; the Science Center's 37 current incubator residents employ another 174. These highly skilled jobs command an average wage of $89,000, contributing $22.0 million to the City of Philadelphia in wage taxes and $42.5 million to the Commonwealth of Pennsylvania in income taxes annually. Each employee also supports an additional 1.68 jobs throughout the region due to indirect and induced economic demand. [8]

6.2. Don't Overstretch the Role of University

The role of University and Industry has changed but up to what extend? The following figures explain the concept.

Innovation & Entrepreneurship

Albert Einstein's definition of insanity: "doing the same thing over and over again and expecting different results"

Have Universities been engaging in a collective form of **"institutional insanity"**?

If Universities need/desire fame (i.e., high rankings) as well as lots of money (i.e., riches) to support operations, then **what should be the true goals** of Universities in Innovation?

Innovation & Entrepreneurship

"Riches" and **"Fame"** for Universities:

1. Profitable companies with significant involvement by University alumni, i.e., **large** amounts of **corporate research funding** and large **corporate donations**
2. Very successful alumni, i.e., **big donations**
3. Lots of tax and other revenue for governments, i.e., increasing government **operating funding** and **special grants** to the Universities

The funds from 1, 2 and 3 will likely (**probably always**) be much larger than any hoped for IP licensing revenue or sale of equity

Innovation & Entrepreneurship

How can University activities best support innovation and entrepreneurship in a healthy and growing local/national economy?

- **Stop "over protecting" Intellectual Property (IP) rights** to the extent that important University-Industry collaborative work never gets started
- **Stop negotiating over undefined future value**
- Universities creating new **start-up companies** based on University research is good, but, **odds of success are very low** (almost non-existent) without market pull/knowledge

Innovation & Entrepreneurship

Major businesses identified with universities:

- Research in Motion (RIM) - Waterloo
- Google – Stanford
- Facebook - Harvard
- Gatorade – University of Florida

If there are over 200 major research-intensive universities in North America (and > 4,000 Universities and Colleges), **why is it so difficult to name additional major university-connected success stories?**

- For example, Alberta's GDP is approx. $300 Billion
- If Industry-University collaborations provide **a 1% increase in the GDP**, this **produces $3 Billion/yr** of additional GDP in Alberta in the existing economy
- How long does it take to grow a start-up company to produce $3 Billion/yr of GDP in the "new" economy?

- How long does it take to grow a start-up company to produce $3 Billion/yr of GDP in the "new" economy? $1,000,000 revenue, 30% annual growth = 30 years

Support Students & Gradutes

How can University activities best support innovation and entrepreneurship in a healthy and growing local economy?

- Don't ignore the creation of new products and new businesses, but don't **over-estimate its potential**, especially its short and medium term potential
- A major support for innovation in the economy comes from **graduates**, especially graduate students, **taking a University-Industry collaborative experience into the economy**
- Support, foster and encourage the entrepreneurial aspirations of undergraduate and graduate students
- Entrepreneur-in-Residence and "Beaver's Den" in 2011, 2012 and 2013 have connected student product/business ideas with successful entrepreneurs/investors

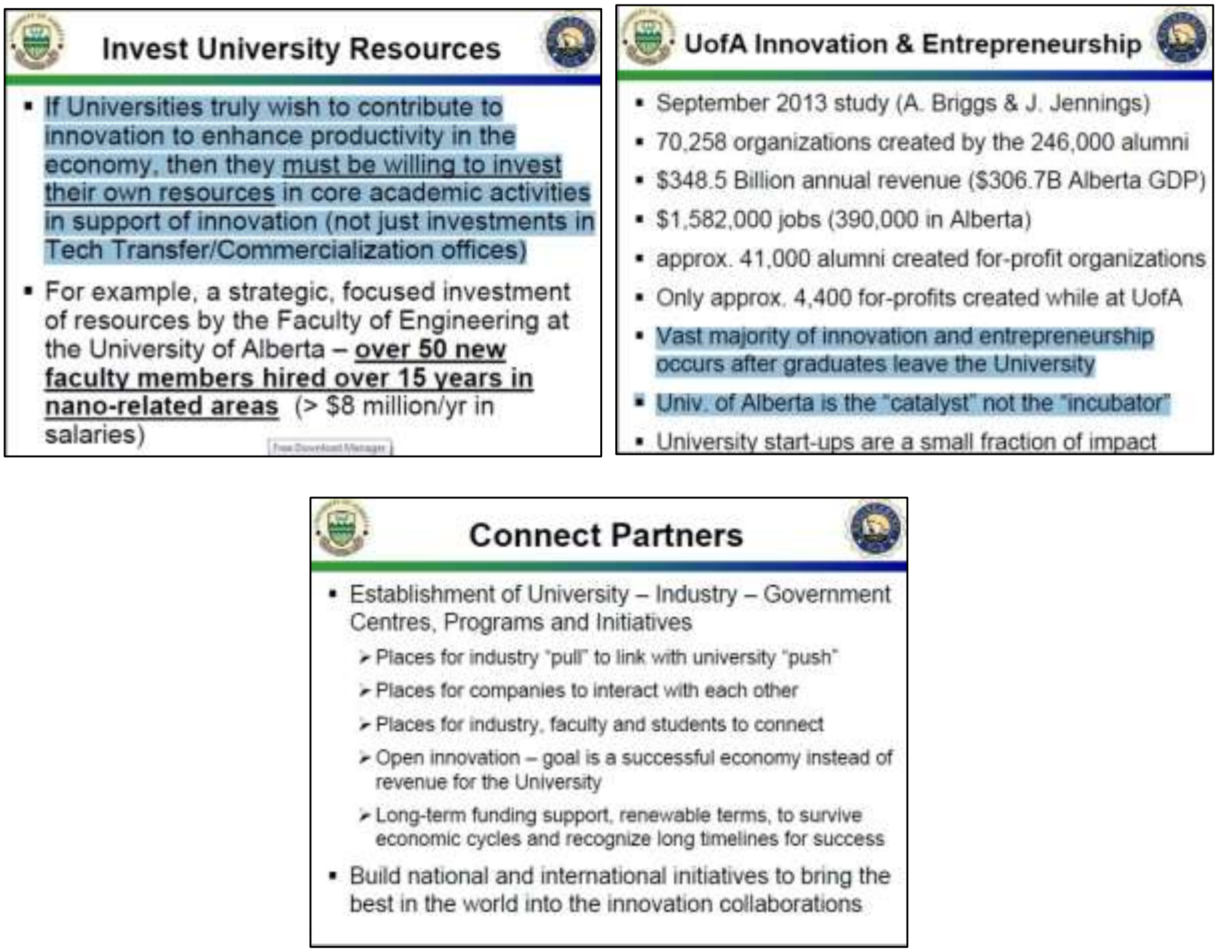
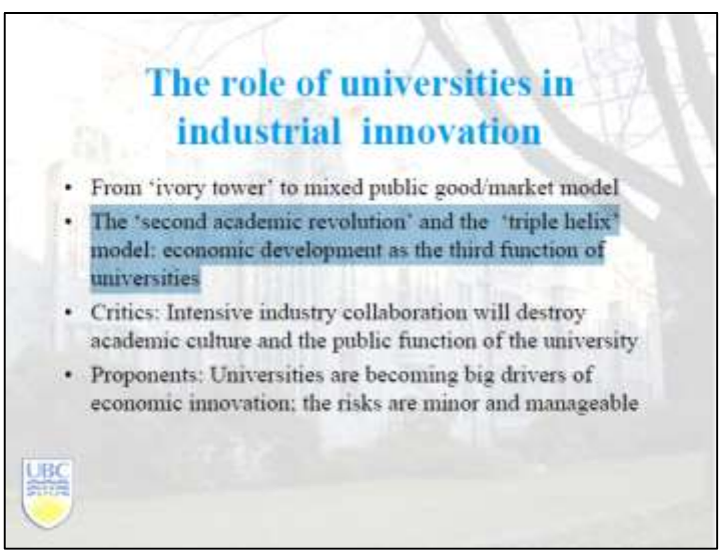


Fig. 6.18: What should be policy of University for Innovation? [7]

Hans G. Schuetze, University of British Columbia, Canada highlighted this issue more clearly in the following presentation. [75]



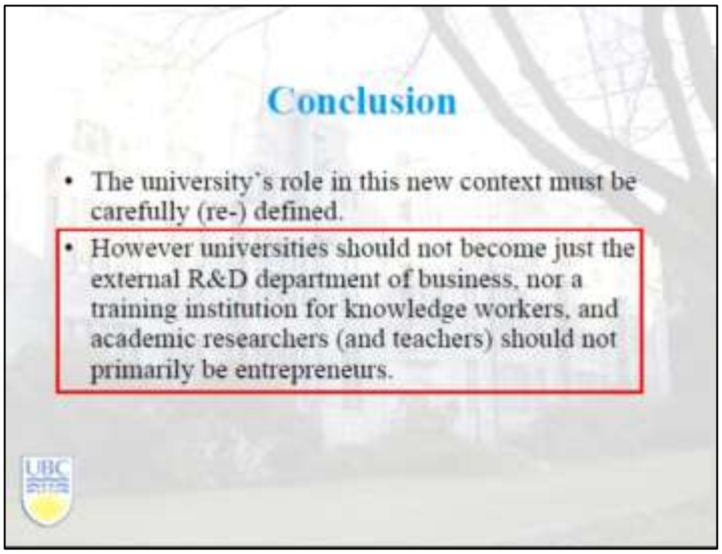


Fig. 6.19: Role of Universities in Industrial Innovation [75]

6.3. Components of a Higher Education Innovation System

As per European Commission, the components of a higher education innovation system primarily include the individual and institutional actors who contribute to generating, diffusing and using innovation in the system. They can act both within and outside the higher education sector, but have a direct interest in the higher education sector. These can be considered as direct actors.

- Direct individual actors include:
  - Students, which can variously be defined as 'junior members', 'consumers' and, of course, 'learners';

  - academic staff (faculty, teaching and research assistants, coaches and mentors, etc.), differentiated in terms of seniority and authority levels, with significant differences in the power of the university professors between different national systems
  - Other staff (e.g. academic administrators and an increasing numbers of new 'professionals' who bridge the traditional divide between academic and administrative roles) such as technology transfer managers, IP experts, patent attorneys, etc.
- Direct institutional actors include:
  - universities with their departments,
  - schools and labs,
  - associated research institutes (often interdisciplinary),
  - technology transfer offices and
  - industrial liaison offices,
  - business support institutions (science parks, business and technology incubators, start-up accelerators),
  - Financial support institutions (public and private venture capital firms, angel networks, seed capital funds, etc.)
- Indirect actors, such as
  - individuals, organizations, or institutions from the social, economic, and political spheres at national, regional and local governments,
  - 'users' of the knowledge created or of the trained manpower produced, such as businesses and employers' organizations, as well as society at large, and
  - Networks of academics, alumni and others, who possess the power to bestow status and reputation.
- Finally, additional components of a higher education innovation system may be found in the regulatory and legislative activity of governments which shape the innovation system. [357]

6.4. Innovation: Performance Comparison of 22 US Universities

Melba Kurman, President of Triple Helix Innovation, has published excellent analysis of **Innovation and US Universities**. I have included few points from this article. For details kindly refer the full article. [62]

This bubble chart compares the biggest U.S. research universities. Here's how to make sense of this chart:
- The vertical axis represents total number of publications for the year 2010
- The horizontal axis represents how many inventions university researchers disclosed that year
- The size of the bubble represents how much industry funding the university got that year
- So, if a university bubble is high up on the chart, that university produces a lot of papers.
- If a university sits out to the far right, it creates a lot of new inventions.
- The bigger the bubble representing a particular university, the more industry funding that university received in 2010.

Not surprisingly, Harvard researchers publish a significantly larger total number of papers than those at other universities. Duke, University of Colorado and Washington University of St. Louis have high levels of research funding from industry sources. CalTech researchers are strong in both paper publishing and creating inventions: on average, for each invention reported by a CalTech researcher, six scholarly papers were published. **The University of Texas and University of California systems aren't depicted here** for the simple reason that their numbers are so large they compress the rest of the university bubbles into a messy blob. That is, Texas and California perform very well. [62]

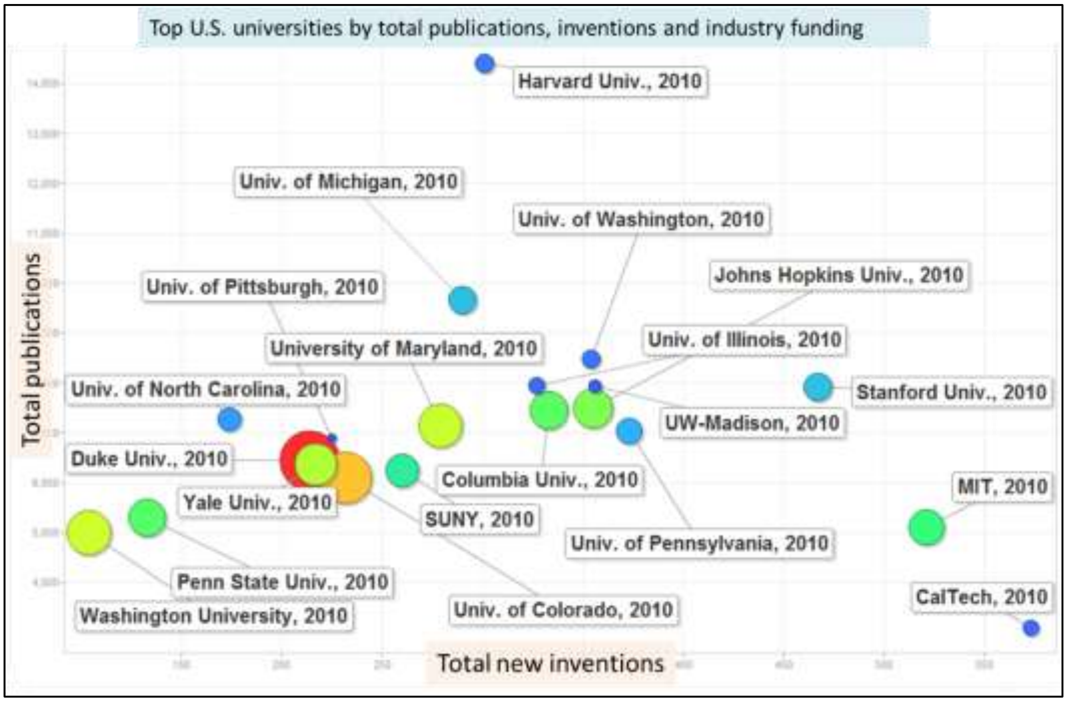


Fig. 6.20. Total Publication and Inventions of 22 US Universities in 2010 (except University of Texas and University of California) [62]

6.5. Innovation Contribution of Renowned Universities of the World

University of Newcastle (UoN) Australia: The 'Jameson Cell' at the UoN - Developed in the 1980's, the revolutionary method of separating valuable minerals and coal from low-yield sources, is now used in 25 countries around the world. Hailed as one of the country's most financially successful inventions in the past two decades, the Jameson Cell adds more than $1.5 billion a year to the value of Australia's minerals export industry. [692]

Recently, a collaboration between **Aachen University, Germany** and 10 companies along with contributions from 50 auto-parts supplier led to the creation of the Street-Scooter, a $7,000 modular electric vehicle. This innovative product can run at top speed of 74 mph with an 80-mile range, using leased batteries. It's already creating a buzz in the automotive industry as the shipping and logistics giant, DHL, ordered 3,500 units of this commercial product to leverage its cost-saving benefits!

Raven II, a surgical robot developed by **University of Washington and UC Santa Cruz** is another fine example of 'open-source' university-industry collaboration. It will be used by some of the most advanced medical research labs at Harvard University, John Hopkins University etc. to enable new surgical procedures. [691]

Lund University, Sweden

- One of the most famous innovations based on research from Lund University is **diagnostic ultrasound**, which is today a routine method of examination in hospitals around the world.
- Second example of pioneering innovation is the **artificial kidney**, which laid the foundations for the multinational company Gambro and which makes life easier for dialysis patients worldwide.
- The third example is "**Bluetooth technology**", which enables wireless communication over short distances. [693]

There are Hundreds of Innovations from renowned Universities. I have quoted just few of them. Mostly these innovations are through University-Industry partnerships. Many interesting examples of University-Industry partnerships have been included in Chapter 10 of my book "Strategy to Develop World Class University".

Chapter 7: Innovation Pedagogy: Training to Enhance Innovation Competencies

As such, what training in innovation provides is not so much a guarantee of becoming the next great innovator, but a guarantee of ***increasing the odds of innovation****.* *[305]*

"*One cannot depend or accept only the idea that* ***innovative concepts come exclusively from 'gifted' people,*** *or that* ***innovation is an intellectual 'accident' of inspiration*** *and not the result of hard and focused work. …* ***Competencies that increase the chances of innovation can now be learned****."* *[299]*

Samsung*'s approach to innovation is not similar to Apple's competitive race style or Google's skunk work project style, but rather it is about systematically developing a group of creative elite that in turn work a methodical creative process. The amount of training that is put into instilling this innovative system in all of the engineers is close to 3 weeks to ensure that they are properly using this innovative method…* ***TRIZ*** *is an innovative method that allows for systematic problem solving by seeking contradictions in current approach… It has been estimated that the TRIZ method saved in excess of $100 million in just its first few projects and is now a* ***mandatory skill for the engineers and creative elite within Samsung****.* *[665]*

7.1. Train People to Develop Innovation: Innovation Competencies

For organizations, **innovation is the key for competitiveness**, being people in the core of the innovation process. Therefore **training people to develop innovation** competencies is a need for all companies that want to be competitive. All these considerations **became a great challenge** for the global educational system and of course for the University, that must to promote creativity and innovation through programs, courses and training. [297]

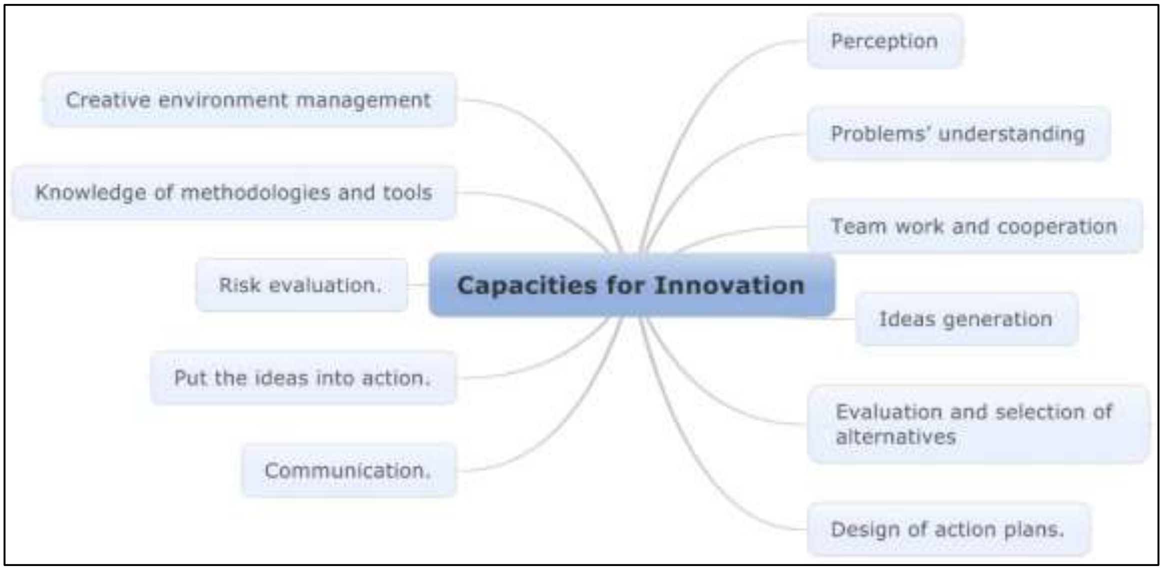


Fig. 7.1: Innovation Competencies [297]

Few Creativity & Innovation Competencies are:

- Accessing and analyzing information
- Active Learning
- Agility and Adaptability
- Collaboration across networks and leading by influence
- Community Building
- Creative thinking
- Curiosity and imagination
- Design and conduct high-performance idea-generation/problem-solving sessions
- Develop critical thinking
- Discovering your Creativity and Innovation styles
- Effective participation
- Effective written and oral communication
- Encourage Problem Solving
- How to enroll others in your ideas
- How to generate, analyze, evaluate and implement ideas
- Independent enquiry
- Initiative and Entrepreneurialism
- Lead creatively

- Manage Creativity and Innovation processes
- Reflective learning
- Risk-Taking
- Self-management
- Strategic decision making skills
- Team work
- The ability to ask the right questions Become an opportunity-finder [359] [360] 361]

7.2. Central Michigan University USA: Innovation Competency Model

To build innovation muscle, **companies must include innovation in their competency models**. **A competency is a persistent pattern of behavior resulting from a cluster of knowledge, skills, abilities, and motivations.** Competency models formalize that behavior and make it persistent. They prescribe the ideal patterns needed for exceptional performance. They help diagnose and evaluate employee performance. It takes a lot of work to develop one, but it's worth it. Here is a nice example of an innovation competency modeled developed at **Central Michigan University** through a collaboration of authors. It could be customized to address the specific needs of a company or industry. The Core Competencies of Innovation are: [298]

Creativity

- Generating Ideas: Coming up with a variety of approaches to problem solving.
- Critical Thinking: Logically identifying how different possible approaches are strong and weak, and analyzing these judgments.
- Synthesis/Reorganization: Finding a better way to approach problems through synthesizing and reorganizing the information.
- Creative Problem Solving: Using novel ideas to solve problems as a leader. [298]

Enterprising

- Identifying Problem: Pinpointing the actual nature and cause of problems and the dynamics that underlie them.
- Seeking Improvement: Constantly looking for ways that one can improve one's organization.
- Gathering Information: Identifying useful sources of information and gathering and utilizing only that information which is essential.
- Independent Thinking: Thinking 'outside the box' even if this sometimes may go against popular opinion.
- Technological Savvy: Understanding and utilizing technology to improve work processes. [298]

Integrating Perspectives

- Openness to Ideas: A willingness to listen to suggestions from others and to try new ideas.
- Research Orientation: Observing the behavior of others, reading extensively, and keeping your mind open to ideas and solutions from others. Reading and talking to people in related fields to discover innovations or current trends in the field.

- Collaborating: Working with others and seeking the opinions of others to reach a creative solution.
- Engaging in Non-Work Related Interests: Being well-rounded and seeking information from other fields and areas of life to find novel approaches to situations. [298]

Forecasting

- Perceiving Systems: Acknowledging important changes that occur in a system or predicting accurately when they might occur.
- Evaluating Long-Term Consequences: Concluding what a change in systems will result in long-term
- Visioning: Developing an image of an ideal working state of an organization.
- Managing the Future: Evaluating future directions and risks based on current and future strengths, weaknesses, opportunities and threats. [298]

Managing Change

- Sensitivity to Situations: Assessing situational forces that are promoting and inhibiting an idea for change.
- Challenging the Status Quo: Willingness to act against the way things have traditionally been done when tradition impedes performance improvements.
- Intelligent Risk-Taking: Being willing and able to take calculated risks when necessary.
- Reinforcing Change: Encouraging subordinates to come up with innovative solutions. Recognizing and rewarding those who take initiative and act in a creative manner. Facilitating the institutionalization of change initiatives. [298]

7.3. Universities of Finland, Spain, Germany and Belgium: Innovation Competency Development Project & Innovation Pedagogy

INCODE – Innovation Competencies Development – is a transnational project addressing the comprehensive goal of finding new curricular concepts for the development of innovation competencies in Higher Education which is part of the European Strategy 2020. The Innovation Competency Development Project (INCODE) includes four European partner universities: Turku University of Applied Sciences from Finland, Universitat Politècnica de València from Spain, University of Applied Sciences Hamburg from Germany and Karel de Grote-Hogeschool Antwerpen from Belgium. The project has received the support of funding through the Life-long Learning Programme of the European Union. The main objective of the project is to create an instrument that will measure outcomes when using innovation pedagogy. The instrument focuses on assessing students' performance in situations that produce samples of capacities and skills that make up innovation competencies. [374] [375]

In **innovation pedagogy**, a learning approach in which students have the opportunity to become **innovative members of learning organizations**, the social aspects of working and learning are emphasized. Group processes where learning happens in **multidisciplinary teams** form an essential part of learning. The aim of innovation pedagogy is to generate environments in which a competitive advantage can be created by combining different kinds of know-how. **Innovation competencies sharpened by innovation pedagogy** are the key to acquiring new competitive advantages via knowhow. [374]

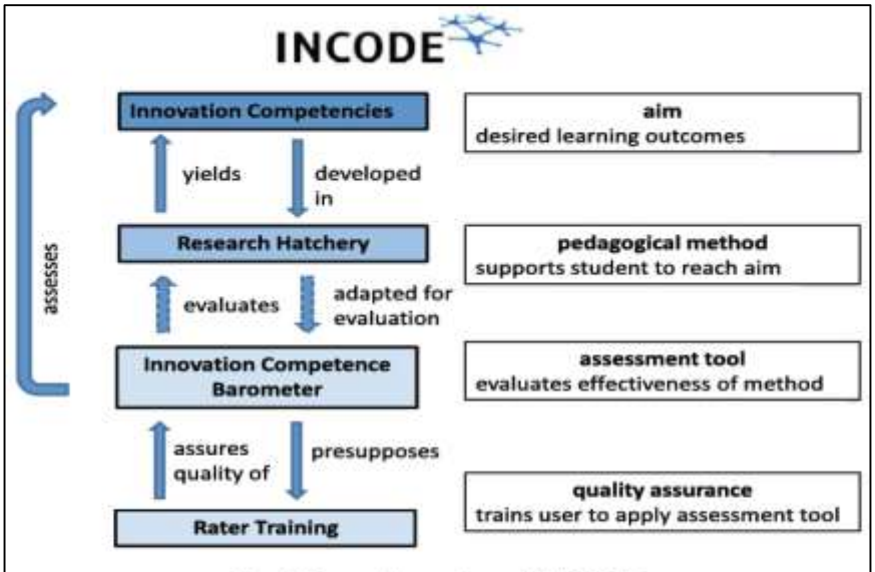


Fig. 1 General overview of INCODE.

Fig. 7.2: The Innovation Competency Development Project (INCODE) of Universities in Finland, Spain, Germany and Belgium [374] [375]

Innovation Pedagogy is an approach in Higher Education that - right from the beginning of the study program - **tends to develop and unfold those capabilities in students that help them to produce innovative results within their field of study**. Innovation Pedagogy tries to bring into accordance the requirements of the labor market for innovative individuals and collectives with the subject-specific learning outcomes in different Higher Education Programs. The development of Innovation Competence therefore may be regarded as a new "cultural approach" in Higher Education. [375]

Innovation is a new discipline born from the understanding and application of methods from several different areas, such as, design, business and social sciences. As a discipline, innovation should help students to understand a context, assess the existing needs, envision opportunities for change and prescribe viable solutions. There are many conditions, knowledge and attitudes that have direct impact on building innovation competencies. [299]

The Research Report of Turku University of Applied Science, Finland stated that **"Innovation pedagogy** is a learning approach, which defines in a new way how knowledge is assimilated, produced and used in a manner that can create innovations…The **innovation competences** selected as the educational targets of innovation pedagogy are divided into three classes. We believe that **interpersonal** and **networking** skills must also be generated in students, in addition to **individual** skills. " [300]

The methods, objectives and learning outcomes of innovation pedagogy are shown in following figure.

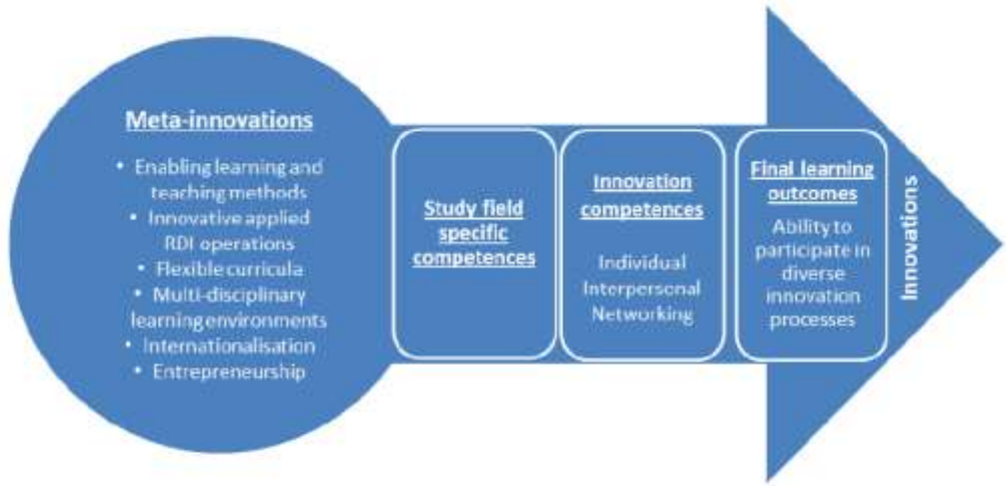


FIGURE 1. *Methods, objectives and learning outcomes according to innovation pedagogy.*

Fig. 7.3: Innovation Pedagogy [300]

TABLE 1. *The INCODE Barometer.*

Name of student	
In the activities in class, the student:	
	INDIVIDUAL
1	Presents ideas that are suitable for the task
2	Presents creative ideas
3	Presents new ways to implement ideas
4	Evaluates the advantages and disadvantages of actions
5	Identifies relationships among different components of the task
6	Faces the task from different points of view
7	Uses available resources ingeniously
8	Foresees how events will develop
9	Shows enthusiasm
10	Persistently pursues the goals
11	Takes daring yet reasonable risks
12	Orients the task towards the target
	INTERPERSONAL
13	Transmits ideas effectively
14	Listens to teammates
15	Establishes constructive group relationships through dialogue
16	Collaborates actively
17	Contributes to group functioning
18	Takes initiatives
19	Drives others to act
20	Faces conflicts with flexibility to reach agreements
	NETWORKING
21	Applies ethical values
22	Takes into account the implications of the task for society
23	Is able to work in multidisciplinary environments
24	Is able to work in multicultural environments
25	Uses networking contacts to reach goals

Fig. 7.4: Innovation Competencies Development (INCODE) Barometer [300]

The INCODE Barometer was constructed to evaluate student development and performance in the complex cluster of innovation competence. The overall assessment design should therefore include a training program for raters to be able to apply the Barometer consistently. [300]

María José Pérez Peñalver and team of Universitat Politècnica de València Spain have published wonderful research work on Innovation Competence and stated that "Innovation competence be developed in three dimensions or scales: **individual, community and networking."** [302]

Individual

People who show a more complex professional performance and lead innovation processes possess a special personal profile; they are somehow different from average individuals. A number of capacities and skills appear in the literature, in which several are outstanding at the individual level.

- The willingness to know and explore the unknown or anything new. These characteristics encompass curiosity, readiness and ability to learn or what is called the Learning Goal Orientation
- Creativity, being inventive and thinking creatively are the most frequently cited capacities in the literature related to innovation.
- Problem solving, ability to conceptualize, and cognitive complexity are other capacities required for innovation
- Managing oneself, being committed, governing oneself or being target-oriented are also essential individual-scale capacities
- Managerial and entrepreneurial skills are held in high esteem. These include entrepreneurship, risk-taking, visioning, volition and initiative or commercial acumen
- Not so frequent but present in the literature are motivation, coping with chaos and uncertainties or the ability to manage complexity
- Autonomy and thinking critically are also relevant for innovation
- Flexibility or receptiveness to innovation have also been noted, as well as training in design and art education or ambition [302]

Interpersonal

In any innovation process there is a fundamental need to establish relationships with other people. In the workplace, individuals will have to use certain abilities that will allow them to handle the work environment and professional situations effectively.

- Communication is one of the most outstanding aspect
- Empathy and emotional intelligence by building trust, being sociable, socially astute and able to influence others, having the ability to read and manage one's own and others' emotions and behavior during social interaction
- Team work is also one of the most relevant, along with the ability to create knowledge collaboratively and manage conflict
- Leadership also stands out and includes team building and steering, coaching, mentoring, lobbying, negotiating, coordination, ethics, charisma [302]

Networking

The networking dimension covers the capacities and skills that involve the relationships among all the actors involved in an endeavor, local or international, be they institutional, commercial or user level. This perspective contemplates a multicultural professional environment where agreement, respect for different approaches and social responsibility help to develop a network, able to provide society with reliable outcomes.

- The so-called "green" or ethical skills. These are crucial to establish the solid foundations for sustainability both in society and innovation processes and outcomes
- Multicultural openness, understanding and communicating across cultures, enjoying contact with dissimilar others
- Consumers skills, i.e., understanding the role of consumers and their power of participation [302]

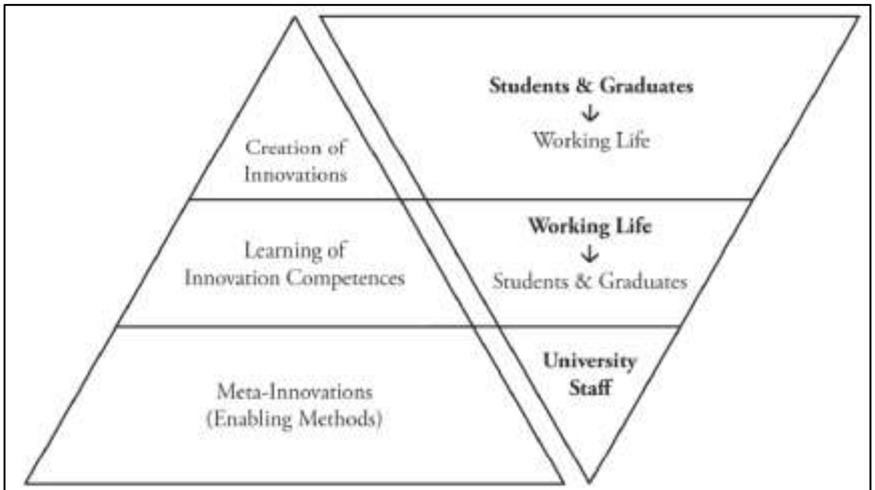


FIGURE 1. *Competence hierarchy of innovation pedagogy and its respective interest groups.*

Fig. 7.5: Competence hierarchy of innovation pedagogy and its respective interest group [301]

These research reports had given number of case studies. Out of which following two are very interesting.

- "Implementation of Innovation Pedagogy in the studies of Automotive and Transportation Engineering" and
- "New Ways of learning in the engineering studies of Energy & Internal Combustion Engine Technology". [301]

In addition to Finland, number of Spanish universities are also involved in the implementation of innovation competence in their degree programs. Two examples are Universitat Rovira Virgili and Universitat de València. You can refer these two interesting research reports for more detailed information. [300] [301] [302]

7.4. University of Southampton, UK: Graduate Attributes & Passport

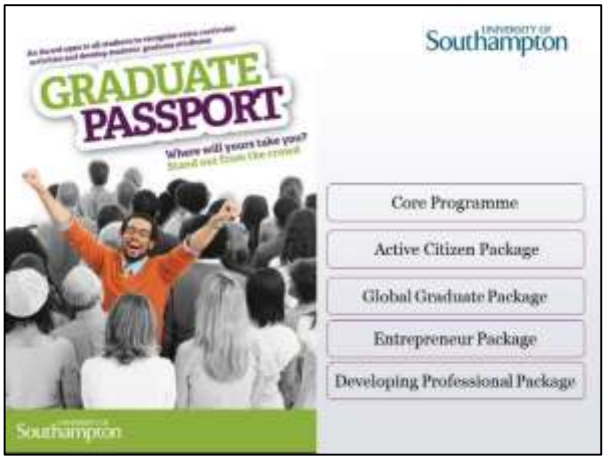


Fig. 7.6: University of Southampton: Innovation Curriculum Design with Graduate Attributes and Graduate Passport [336]

The Graduate Passport is a record of achievement which rewards students for participating in various extra-curricular activities alongside their degree programme. The scheme is open for all students to achieve including undergraduates to postgraduate students. Points based programme which consists of a selection of over 60 possible activities which are completed to achieve your passport Once you have completed your Graduate Passport you will awarded with a Graduate Passport certificate at one of our summer award ceremonies (The Graduate Passport is not associated with the UK visa process).

- Active Citizen Package: This package focuses on community involvement and citizenship incorporating activities such as volunteering work, becoming an active member of societies and representing your academic department or the Students' Union. Some of the skills you will develop within this package form the top 3 ‘soft’ skills that Employers look for in graduates – communication, team-working and integrity.
- Entrepreneur Package: This package focuses on creativity, business, social enterprise and initiative through various projects and activities. Suggested attributes you will hone with this package include commercial awareness, leadership skills, creativity and ingenuity, all of which are increasingly desirable with employers and organizations. It can range from getting involved in media projects to setting up a small business, addressing entrepreneurial skills in its widest sense.
- Global Graduate Package: In a global market place, international awareness is a key skill many employers value. Being internationally aware does not mean you have to travel and work abroad, although options are available if you choose to do this. Instead it can be about engaging with different cultures and expanding your knowledge while remaining in the UK. Activities for this package also include language taster classes, attending the Global Advantage Conference, befriending an international student, translating publications, studying, working or volunteering abroad and presenting at an international conference or event.
- Developing Professional Package: This package enables you to participate in a range of activities from across the set packages above to develop a broad spectrum of experiences to reflect on. This package is ideal for those who want to experiment with a wide range of experiences or who are undecided about the direction of their career journey. It also enables

you to develop a range of professional interests, work experiences and transferable skills by choosing relevant options from each package. [337]

7.5. Middle East Technical University, Turkey

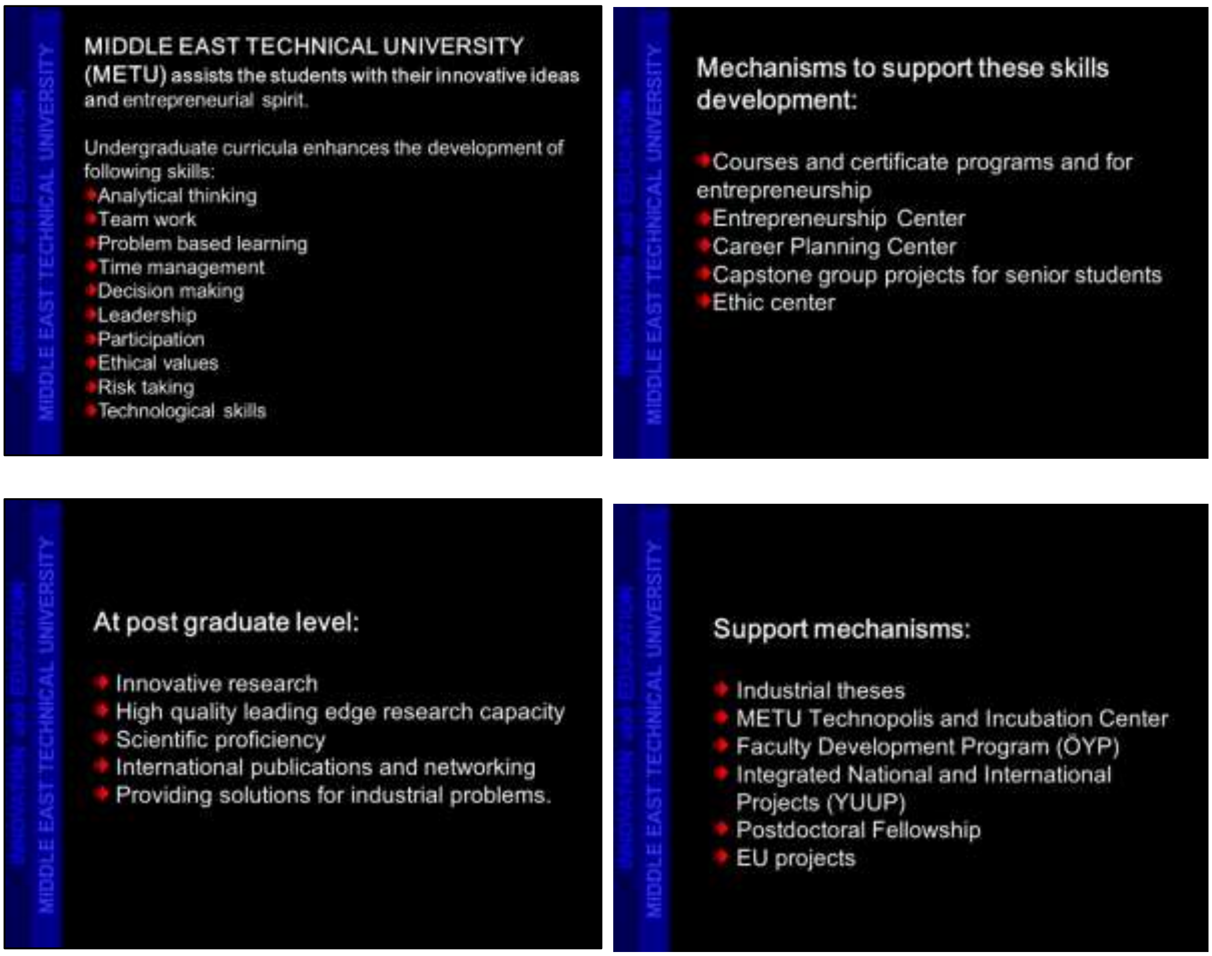


Fig. 7.7: Middle East Technical University, Turkey [339]

7.6. Griffith University Australia: Graduate Attributes Creativity and Innovation Toolkit

This Toolkit, Creativity and Innovation, focuses on how you can help students to think and learn creatively and develop their **innovative skills** while at university. In the following table last column shows number of took kits developed by this university. [340]

GRADUATE ATTRIBUTES	DESCRIPTOR	TOOLKIT
(1) Knowledgeable and Skilled in their Disciplines	Comprehensive knowledge and skills relating to their disciplines	n/a
	An interdisciplinary perspective	**Interdisciplinary Skills**
	Capacity to find, evaluate and use information	**Information Literacy**
	Ability to apply discipline/professional skills and knowledge in the workplace	**Professional Skills**
(2) Effective Communicators and Team Members	Capacity to communicate effectively with others orally	**Oral Communication**
	Capacity to communicate effectively with others in writing	**Written Communication**
	Capacity to communicate effectively with others using ICTs, multimedia, visual, musical and other forms appropriate to their disciplines	**ICT and Other Discipline-Related Communication Skills**
	Capacity to interact and collaborate with others effectively, including in teams, in the workplace, and in culturally or linguistically diverse contexts.	**Teamwork Skills**

GRADUATE ATTRIBUTES	DESCRIPTOR	TOOLKIT
(3) Innovative and Creative, with Critical Judgement	Ability to use knowledge and skills to devise solutions to unfamiliar problems	**Creativity and Innovation***
	Ability to analyse and critically evaluate arguments and evidence appropriate to their disciplines (e.g. collect analyse and interpret data and information, generate and test hypotheses, synthesise and organise information)	**Critical Evaluation**
	Knowledge of research methodologies in their disciplines and capacity to interpret findings	**Research Skills**
	Ability to generate ideas/products/art works/methods/approaches/perspectives as appropriate to the discipline.	**Creativity and Innovation***
(4) Socially Responsible and Engaged in their Communities	Ethical awareness (professional and personal) and academic integrity	**Ethical Behaviour and Social Responsibility***
	Capacity to apply disciplinary knowledge to solving real life problems in relevant communities	**Problem Solving**
	Understanding of social and civic responsibilities, human rights and sustainability	**Ethical Behaviour and Social Responsibility***
	Understanding the value of further learning and professional development	**Further Learning**
(5) Competent in Culturally Diverse and International Environments	Awareness of and respect for the values and knowledges of Australian Aboriginal and Torres Strait Islander First Peoples	To be developed
	Respect, awareness, knowledge and skills to interact effectively in culturally or linguistically diverse contexts	**Global and International Perspective and Awareness***
	A global and international perspective on their disciplines.	**Global and International Perspective and Awareness***

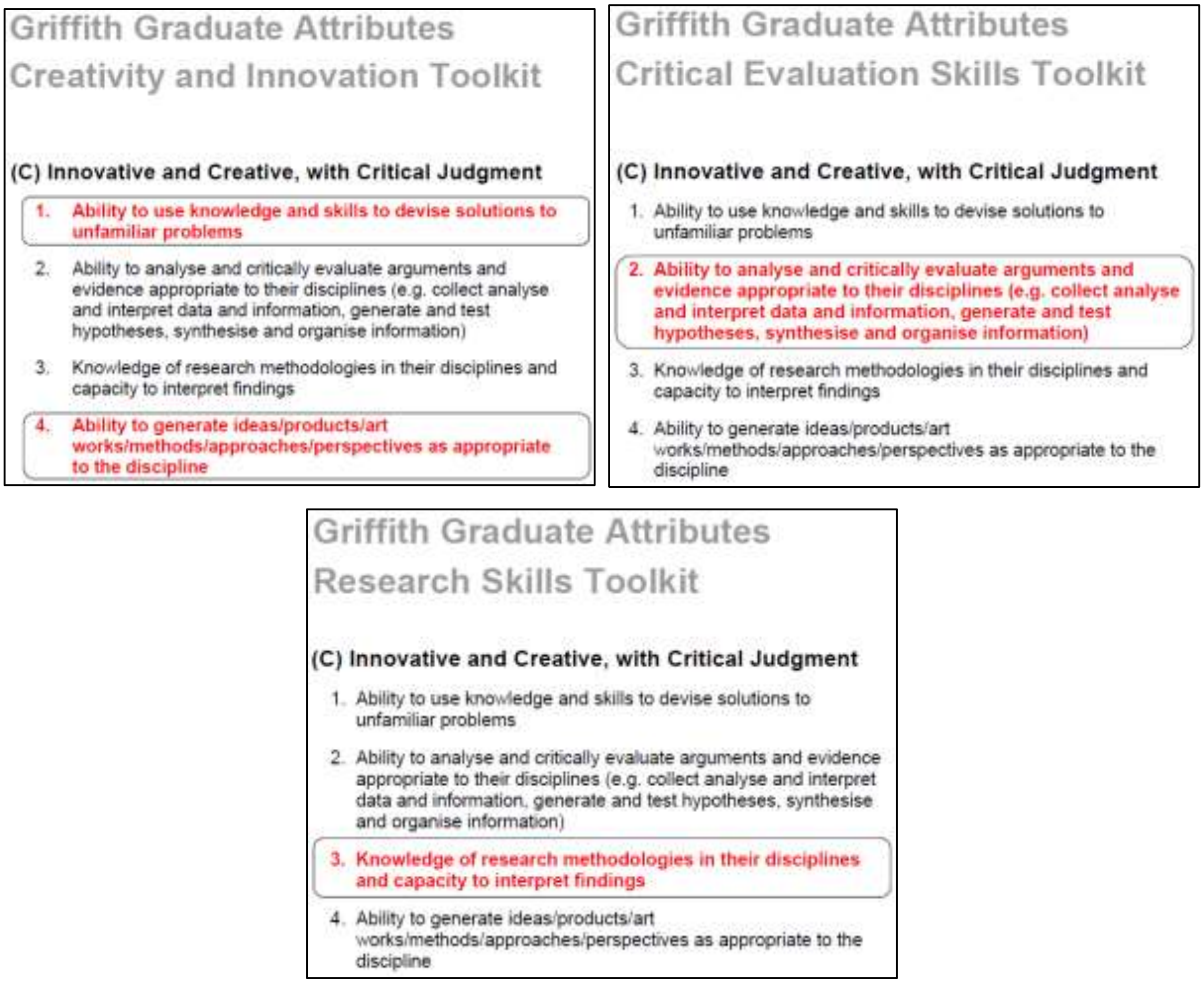


Fig. 7.8: Griffith University Australia: Graduate Attributes Creativity and Innovation Toolkit, Critical Evaluation Skills Toolkit and Research Skills Toolkit [340] [341] [342]

There are many toolkits available at the website of the university, which can be downloaded freely.

"A talent, or gift for creativity can be inherited by some people, and **learned or developed by others**. It is not true to say that people just are creative, while others aren't – rather that some people find it easier to recognize their creativity and run with it, **while others are more hesitant**. Recent thinking shows that the **ability to think and act creatively can indeed be fostered in the classroom and transferred or applied in different learning contexts**." [340]

Some universities have developed specific courses that focus primarily on creative, innovative thinking and problem solving. Academic staff at **Harvard University**, for example, have formed a centre to help engineers and scientists become more creative and entrepreneurial. The **University of Strathclyde**, UK has developed a specific course. [340]

The **Open University, UK**, has found that "it is possible to promote students' creativity and innovation if some key conditions are met, namely: The curriculum must integrate different techniques for creativity and innovation (brainstorming, group work, etc.); [340]

"Creativity is about originality and innovation and not about repeating what has already been done. This means you expose yourself to the possibility of failure. There are risks associated with extending personal boundaries. There is a **mindset needed to go beyond personal comfort zones**. An understanding of risk – and how to learn from it – along with the mind tools needed to develop creativity, are the components of the course." [340]

The innovation in Curricula can increase the University-Innovation-Contribution through developing the Innovation Competencies of the students. Some fundamental principles underlie curriculum design for **creativity and innovation** include:

- Designing curricula that foster:
    - Development of appropriate thinking skills;
    - Acquisition of positive attitudes to creativity and creative performance;
    - Motivation to be creative;
    - Perception of oneself as capable of being creative;
    - Reduction of anxiety about creativity; and
    - Positive attitude and mood in problem-solving situations. [340]
- Making "being creative and innovative" part of learning:
    - Encourage students to generate lots of ideas – some of them will be creative and original – in group brainstorming sessions, and individually;
    - Get students to see things from different perspectives – take a different approach – ascribe them particular "professional roles" (e.g., an accountant; a lawyer; a project manager; a gallery director; a stage producer) to change their point of view;
    - Ask them to build on and expand existing ideas to arrive at new ones;
    - Recognize the importance of asking questions and being inquisitive;
    - Ask students provocative questions, e.g., "What would happen if…?";
    - Encourage and reward risk-taking by providing genuine support;
    - Assure students that they can be creative;
    - Allow time for students to think.
- Giving students plenty of practice in solving problems creatively: Finding and framing the problem to be solved is often the most creative part of problem solving. Encourage students to recognize problems when they see them, try out a range of possible solutions, and then evaluate the most effective fit between the problem and its solution.
- Encouraging students to "think like innovators": Engage students in group brainstorming sessions;
    - Ask students to consider not just one, but two or more alternative problems, and solutions – use the "what if?" approach;
    - Suggest they keep a comprehensive journal of their thoughts, ideas and experiences – a Visual Diary is ideal – as some of them might be worth developing;
    - Suggest students use a tape-recorder to note down their thoughts and ideas throughout the day;
    - Introduce them to concept mapping to make connections between ideas;
    - Engage them in word association exercises (for the same reason).
- Sharing examples of creative, innovative thinking from inside and outside the classroom, from a range of disciplines
- Some teaching and learning strategies to develop creativity
    - Brainstorming

  - Mind Mapping
  - Six Thinking Hats
  - Visual Brainstorming
  - Synectic Strategies [340]

7.7. Brigham Young University USA: Teaching Creativity and Innovation

Richard E. West and team, Brigham Young University has explained the concept of teaching creativity and innovation nicely in his research paper and designed the teaching program for undergraduate engineering students. [355]

7.7.1. Teaching Creativity

Over the years hundreds of creativity training methods have been developed. The two major objectives of creativity training:

- Stimulate the development of creative potential and
- Help individuals acquire skills and knowledge necessary to generate creative ideas. [355]

7.7.1.1. Developing Creativity Potential

Training programs such as Hemisphericity, Psychogenics, and Psychosynthesis are designed to develop the brain's ability to make the mental associations necessary for creative activities through imagery and relaxation, as well as through artistic, musical, and physical exercises. [355]

7.7.1.2. Generating Creative Ideas

Unlike the training to develop creative potential, other creativity training programs teach participants practical skills for generating creative ideas. Most of these programs teach participants to use divergent thinking—a cognitive process for generating multiple and complex ideas from a simple idea. Perhaps the best known and best researched creative idea generation training programs are Osborn's brainstorming program and CPS program.

- **Osborn's brainstorming program**: Osborne established team rules and procedures to maximize the effectiveness of a group of people in generating a large number of ideas.
- **The Creative Problem Solving (CPS) program**: The CPS uses these principles of brainstorming, but additionally helps participants create plans for the development and implementation of their creative ideas. Similar to brainstorming, CPS encourages participants to work in groups. The CPS has five stages:
  - Fact-finding,
  - Problem finding,
  - Idea finding,
  - Solution finding, and
  - Acceptance finding.

- The Six Thinking Hats, an application of lateral thinking, teaches participants to use six different mindsets, such as logical, emotional, and critical, to understand a problem.
- The SCAMPER technique requires participants to identify key attributes of a problem and substitute, combine, adapt, modify, put to other uses, eliminate, or rearrange these attributes (Nickerson, 1999). The SCAMPER activities are believed to help participants make unusual associations of different attributes, leading to creative ideas.
- Theory of Inventive Problem Solving (TIPS or TRIZ) teaches participants to systematically analyze a problem and create a solution using algorithmic procedures. [355]

7.7.2. Teaching Innovation

To promote the transformation of creative ideas into innovative solutions, three instructional approaches are commonly used.

- First, innovation training often teaches user- or human-centered design
- Second, participants are often asked to work in multidisciplinary teams
- Third, these teams typically engage in project-based learning (PjBL) [355]

7.7.2.1. User-Centered Design

Marketability is an important aspect of innovation. It suggests that the final product has to be a reliable and useful product with a target audience to benefit. User-centered design increases product marketability. To be user-centered emphasizes identifying and evaluating the relationship between users, products, and environments. User-centered design forces designers to focus on the experience of actual users. The product has to work reliably, but it has to be easy and pleasant to use. Prototyping is strongly encouraged, and prototype evaluation by actual users begins early. [355]

7.7.2.2. Multidisciplinary Teams

The second main feature of innovation training is its emphasis on multidisciplinary teams. Team diversity is a major indicator of creative performance. According to Kostoff (2003), teams consisting of individuals with diverse expertise from various professional fields facilitate dynamic synergies often leading to innovation. Hoffman and Maier (1961) found that heterogeneous groups with diverse personalities that included both genders generated higher quality problem solutions. In addition, products or services provided by organizations now require expertise from multiple professional fields due to increasing complexity. In such organizations multidisciplinary teams are essential. [355]

7.7.2.3. Project-Based Learning

Finally, innovation training often utilizes project-based learning (PjBL). PjBL is an instructional methodology used to provide more authentic and engaging learning experience. Participants are required to find and investigate the problem, then develop and evaluate the solutions. Design and engineering courses taught in many U.S. universities apply this methodology in their capstone projects, in which students form teams and design and develop a product for actual clients. Such practical and authentic experience should be used more often to teach students to be innovative. [355]

7.8. University of London: Fostering Creativity within Engineering

The project explored how creativity in engineering may be fostered and assessed in education and practice. It provides a framework for implementing and evaluating creative programmes. The project was based on the analysis of five case studies and a review of the literature. An 'enthusiast network', serving as an advisory group for the project, included representatives from industry, academia and educational development. The project constructed a working definition of creativity as 'shared imagination' and examined the positive conditions that foster this. These conditions include personality characteristics, individual motivation, skills, knowledge, attitudes, and environmental factors. Motivators of creativity include rewarding innovation and creativity as part of student assessment and lecturer evaluation, as well as developing a safe environment for creativity. Stimulators to creativity include such techniques as:

- Brainstorm at the beginning of lectures to bring students' knowledge to the fore and allow lecturers to adjust their teaching
- Visualization: asking students to collect all manners of items which they can see, hear, feel, to allow them to explore different perspectives and ways of looking at a problem
- Set open-ended problems and, after a short briefing, asking students to reformulate the problems, discuss ideas, and find a variety of solutions
- Develop a voluntary, student-led group, to work on problems set by companies
- Schedule all the lectures of the 'creative' type in a block to help maintain the necessary way of thinking
- Allow students to deconstruct their courses and consider how these can be reorganized
- Assess student learning through a variety of feedback methods such as filming students in action to help them reflect on their own learning, holding small group discussions at the end of each course, asking students to write short-reflective essays on their work, and using groups to critique projects

The project produced a useful and well referenced handbook entitled CASE – how to foster creativity. [356]

7.9. University of Otago New Zealand: Strategic Design Program

Charles Bezerra, University of Otago, New Zealand stated that "Innovation is not only the act of introducing something new, but it is to introduce something new that becomes widely adopted. A very challenging task, but well rewarded in open markets. In today's competitive economic context, which demands innovation, **one cannot depend or accept only the idea that innovative concepts come exclusively from 'gifted' people, or that innovation is an intellectual 'accident' of inspiration** and not the result of hard and focused work. The innovation discipline is still in its infancy, but **competencies that increase the chances of innovation can now be learned**.” [299]

Innovation can assume different forms (it can be a new product, system, process, message, environment, software, or service, to name a few); but so far it begins only in one place – our minds. Innovative solutions are condensed information. It is the result of a complex cognitive ability, and therefore, influenced by **knowledge** as well as **attitudes**. For example, it requires strategic and systemic thinking as well as patience and self-motivation. [299]

Specialization can be seen as a mortal sin for the real innovator. Innovators are specialized generalists; their success comes from their ability for seeing connections. Innovation requires a balanced intellectual attitude that also involves: the ability to avoid excessively broad or narrow generalizations, or confusion from cross-coupling; the ability to acknowledge mistakes and un-productive paths; and the ability to discard useless information.

Innovation is a new discipline **born from the understanding and application of methods from several different areas**, such as,

- Design,
- Business and
- Social Sciences.

As a discipline, innovation should help students to understand

- A context,
- Assess the existing needs,
- Envision opportunities for change and prescribe viable solutions.

There are many conditions, knowledge and attitudes that have direct impact on building innovation competencies. Some key elements for an efficient innovation program of study are:

- **Critical Discussion:** To engage in critical discussion, is probably the first thing the innovation students should learn. The goal is to learn through criticism, from others, and also from self-criticism. To learn from mistakes; learn to correct mistakes and improve their concepts. Dogmatic thinking blocks any process of innovation. When students are used to critical discussion they will realize that they or anyone else possesses the truth; and that everyone is capable of achieving innovative ideas. Therefore, in the discipline of innovation there are no too-silly or too-obvious questions. Critical thinking is key to build innovation competence, students have to learn how to value criticism, not avoid it. And this can be easily done trough teamwork activities and presentations where critical debate is encouraged.
- **Strategic Focus (knowledge):** To think strategically is also a crucial competence in the discipline of innovation. It is hard to explain what strategically or strategy really means, but the main idea is to help students to look for the ‘big picture’ when they are asked to innovate. It is about helping them to take a distant perspective on what is close, and to take a close view on what is distant. It also involves thinking in terms of goals and the resources to achieve these goals. But above all, innovation strategy means planning the designing process; planning the activities and actions necessary to understand and solve the innovative problem. Strategic thinking can be introduced through several class exercises involving games and student

competitions; and developed through research, analytical and creative activities that reflect a general process of innovation.

- **Dependence on Methods (knowledge + attitude):** For the discipline of innovation, methods, processes and tools are fundamental. Students should learn to trust in their methods and techniques. They might not know anything about a particular problem, but they know that after applying their process of research and analysis, they will be able to generate innovative solutions. They should not believe they are especially creative, but that they have a toolbox (frameworks, methods, techniques) that enables them to make innovative interventions. In a sense, students of the innovation discipline should see themselves as batman-like super heroes, for much of their power comes from their utility-belt. Therefore, the innovative program should focus in mastering students in methods and techniques of research, analysis and synthesis.
- **Human-Centered Approach (knowledge + attitude):** It is now very clear that most powerful innovations, the ones that become widely adopted, are those in which the focus of the process is not centered on the technology, or on the market, or still on the designer, but are those, which are centered on the end users. In a human-centered process, the question for whom we design comes first; than the question what we design comes second; and for last, comes the question of how we will implement it. The innovation students should learn that the success of their innovation is directly associated with the value it brings for peoples' lives. Therefore, a successful program of study should include techniques for accessing people' needs. Innovation students should believe they can change the world and improve peoples' lives, they should think humanity is their main customer. More than ever, we need innovations that can help us to fix some problems in our man-perturbed world.

The goal of the **Strategic Design program** at the University of Otago is to help students to build innovation competencies, so they can efficiently cross the gap between need and offer in any business situation.

- To learn to think strategically through theory and methods.
- To develop a macro perspective on a specific business context.
- To research and understand quantitative and qualitative information
- To understand market/consumer/user needs
- To explore opportunities for developing breakthrough products, systems or services.
- To learn from successful business-cases from different markets
- To perform well in the initial/strategic phase of any product development process

The program of study consists of lectures (theory, reading and debate) and tutorial or seminars (project). The theory introduces diverse topics such as,

- Strategic planning;
- Game and
- Complexity theory; and
- Seeks to cover logical, ethical and rhetorical aspects of innovation. Logical in the sense it utilizes methods and rationale for problem-finding and problem-solving. Ethical because it encourages debate about the innovator' responsibilities towards the others and the environment. And, rhetorical because if develops communication and presentation skills.

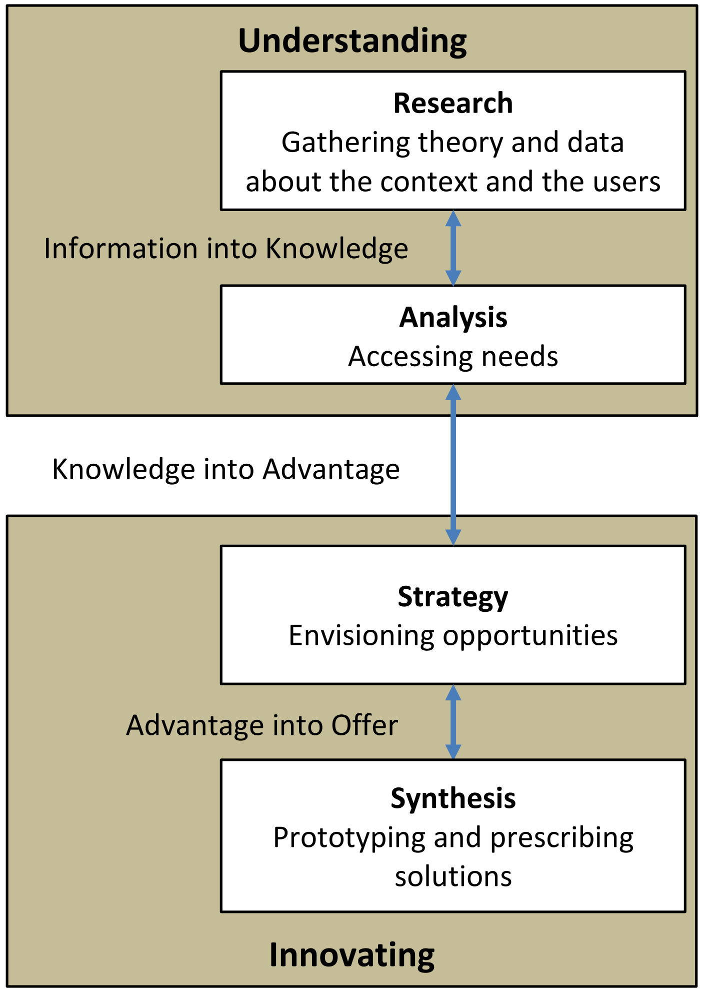


Fig. 7.9: University of Otago: Innovation Competency Development Framework

- Research
    - User-research (observations targeted at understanding their end-user)
    - Technology research (targeted at understanding the means and technological resources related to their projects)
    - Market-research (oriented to have a picture of the market their project is directed towards)
    - Social and cultural research (targeted at understanding the social and cultural forces that affect their topic, from a local and global perspective)

  Several ethnographic techniques are used to conduct user-observation. The main are:
    - Video/photo ethnography
    - Disposable camera studies
    - Material culture studies
    - In-depth interviews
    - Shadowing

  - AEIOU – an easy-to-remember observation framework which oriented to observing and collecting data concerned with: A – the activities (what the users are doing?); E – the environments (where? how is the space?); I – the interactions (interacting with whom? how?); O – the objects (using what objects and tools?); and U- the users (who are them?).
- Analysis: It is on the analysis phase that data is transformed into knowledge, which involves seeing from a higher perspective to identify the patterns and access the needs. Depending on their project, students are advised to apply several analytical techniques:
  - Profiles
  - System decomposition.
  - Social/ Activity Network analysis
  - Technology forecasting
  - Social/Cultural trends
  - Positioning maps
- Strategy: Strategy is the first phase of the innovating dimension. In this phase students are oriented to focus on exploratory, creative and problem-solving activities. In the strategic phase, insights are transformed in strategies for solutions.
  - Opportunity exploration
  - Playing ahead
  - SWOT
  - Strategy Definition
- Synthesis: In the synthesis phase, strategies are transformed into ideas and concepts to be developed. The essence of synthesis is visualization, testing and communication of ideas.
  - Concept development
  - Scenario making
  - Prototyping
  - Implementation and change plan
  - Communication

7.10. TRIZ Russian acronym for "Theory of Inventive Problem Solving"

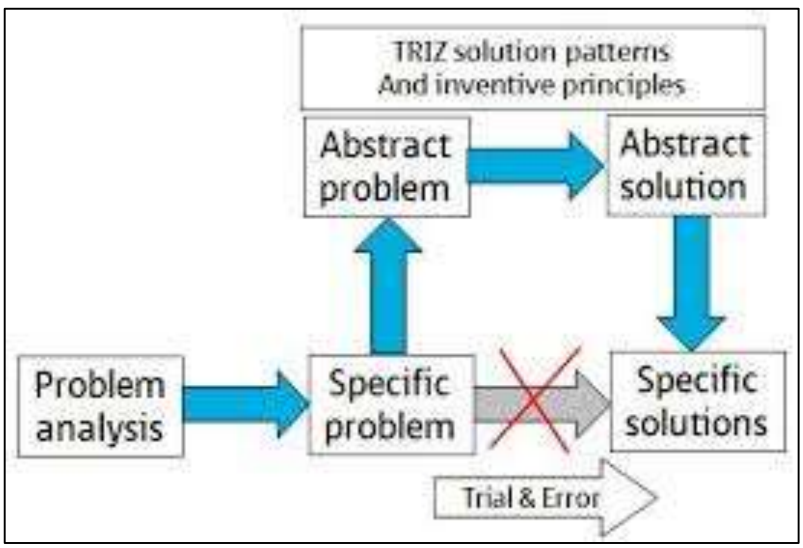
TRIZ is a problem solving methodology based on **logic, data and research**, **not intuition**. It draws on the past knowledge and ingenuity of many thousands of engineers to accelerate the project team's ability to solve problems creatively. As such, TRIZ brings repeatability, predictability, and reliability to the problem-solving process with its structured and algorithmic approach.

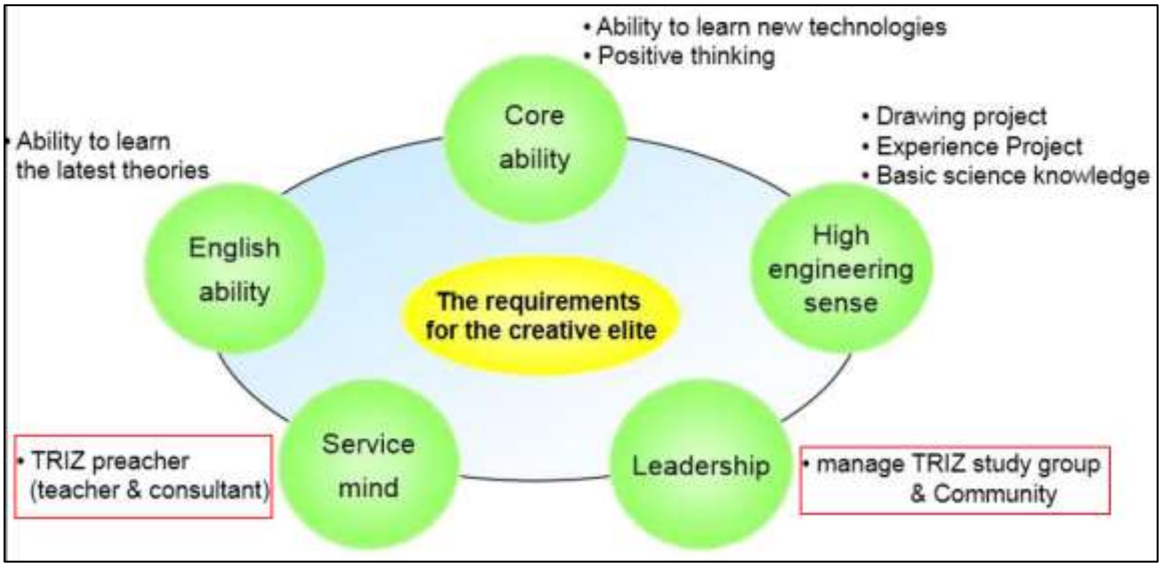
TRIZ is "a problem-solving, analysis and forecasting tool derived from the study of patterns of invention in the global patent literature". It was developed by the Soviet inventor and science fiction author Genrich Altshuller and his colleagues, beginning in 1946. In English the name is typically rendered as "**the theory of inventive problem solving**", and occasionally goes by the English acronym TIPS. Following Altshuller's insight, the theory developed on a foundation of extensive research covering hundreds of thousands of inventions across many different fields to produce a theory which defines **generalizable patterns in the nature of inventive solutions** and the distinguishing characteristics of the problems that these inventions have overcome. [661]

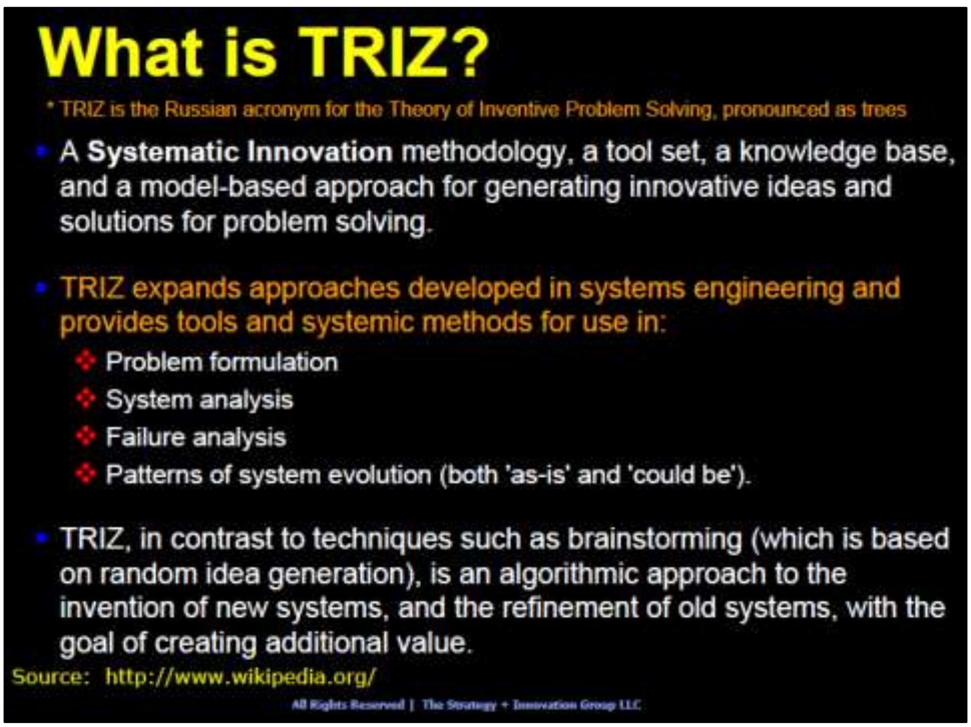
An important part of the theory has been devoted to revealing patterns of evolution and one of the objectives which has been pursued by leading practitioners of TRIZ has been the development of an algorithmic approach to the invention of new systems, and the refinement of existing ones. The theory includes a practical methodology, tool sets, a knowledge base, and model-based technology for generating new ideas and solutions for problem solving. It is intended for application in problem formulation, system analysis, failure analysis, and patterns of system evolution. [661]

Samsung and TRIZ: …But a second effect of the relationship with Russian science was the **introduction of TRIZ, an innovation method that Samsung adopted from 2000 onwards** but which only reached American companies from the mid-2000s onwards (Intel is a user). **TRIZ is a methodology for systematic problem solving**. Typical of its origins in Russia, it asks users to seek the contradictions in current technological conditions and customer needs and to imagine an ideal state that innovation should drive towards.

Samsung had early successes with TRIZ, saving over $100 million in its first few projects. It was also adopting Six Sigma at the time. But it was **TRIZ that became the bedrock of innovation at Samsung**. And it was introduced at Samsung by Russian engineers whom Samsung had hired into its Seoul Labs in the early 2000s. **In 2003 TRIZ led to 50 new patents** for Samsung and in 2004 one project alone, a DVD pick-up innovation, saved Samsung over $100 million. **TRIZ is now an obligatory skill set if you want to advance within Samsung**. At the Samsung Advanced Institute for Technology, Hyo June Kim, who wrote The **Theory of Inventive Problem Solving, a foundation text on TRIZ published in Korean, trained over 1,000 engineers across Samsung companies in 2004 alone**. [660]




• Ability to learn new technologies
• Positive thinking
Core ability
• Drawing project
• Experience Project
• Basic science knowledge
• Ability to learn the latest theories
English ability
The requirements for the creative elite
High engineering sense
• TRIZ preacher (teacher & consultant)
Service mind
Leadership
• manage TRIZ study group & Community


What is TRIZ?
* TRIZ is the Russian acronym for the Theory of Inventive Problem Solving, pronounced as trees
A Systematic Innovation methodology, a tool set, a knowledge base, and a model-based approach for generating innovative ideas and solutions for problem solving.
TRIZ expands approaches developed in systems engineering and provides tools and systemic methods for use in:
Problem formulation
System analysis
Failure analysis
Patterns of system evolution (both 'as-is' and 'could be').
TRIZ, in contrast to techniques such as brainstorming (which is based on random idea generation), is an algorithmic approach to the invention of new systems, and the refinement of old systems, with the goal of creating additional value.
Source: http://www.wikipedia.org/
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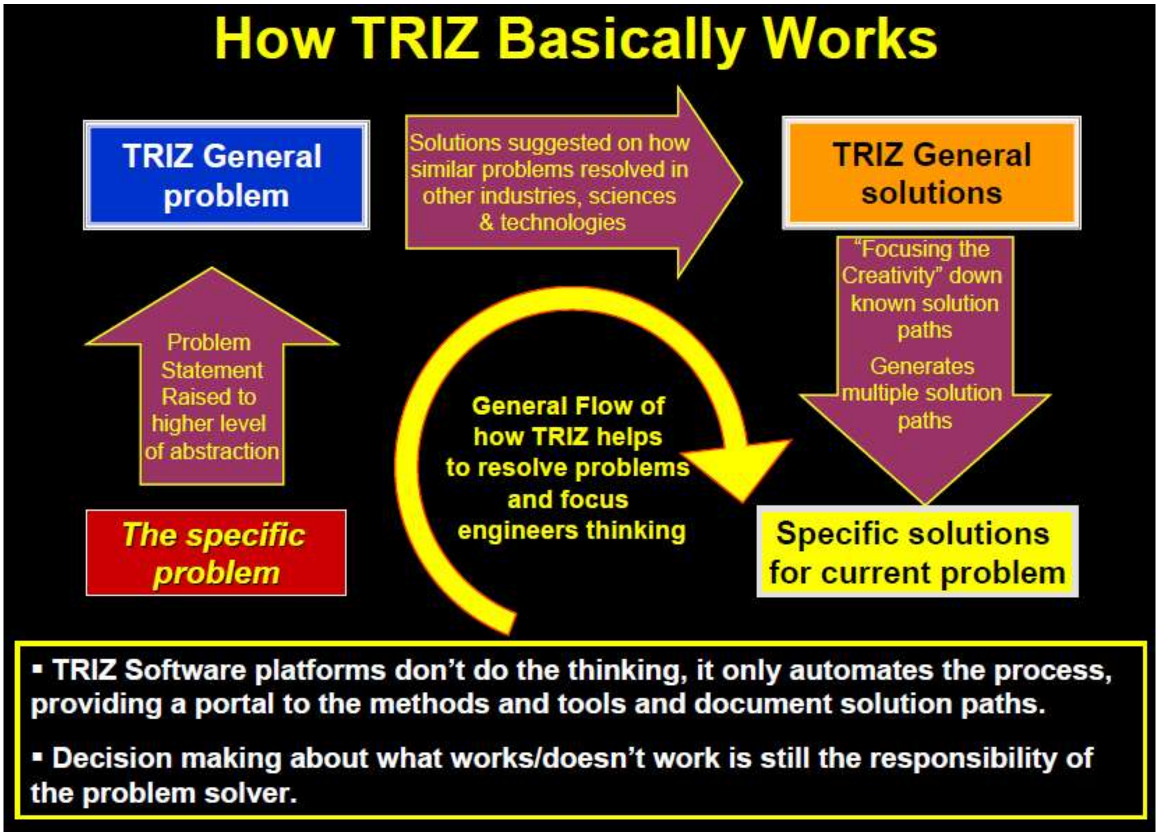
How TRIZ Basically Works
TRIZ General problem
Solutions suggested on how similar problems resolved in other industries, sciences & technologies
TRIZ General solutions
"Focusing the Creativity" down known solution paths
Generates multiple solution paths
Problem Statement Raised to higher level of abstraction
General Flow of how TRIZ helps to resolve problems and focus engineers thinking
The specific problem
Specific solutions for current problem
▪ TRIZ Software platforms don't do the thinking, it only automates the process, providing a portal to the methods and tools and document solution paths.
▪ Decision making about what works/doesn't work is still the responsibility of the problem solver.


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Motivation to Use TRIZ
TRIZ improves an engineer's ability to get to the fundamental root cause of problems along with suggesting potential innovative solutions.
▪ More motivating to engineers than fire fighting
▪ Compelling evidence that TRIZ has been used to help solve technical problems and enhance the innovativeness of world class companies
Companies using TRIZ or its variations:

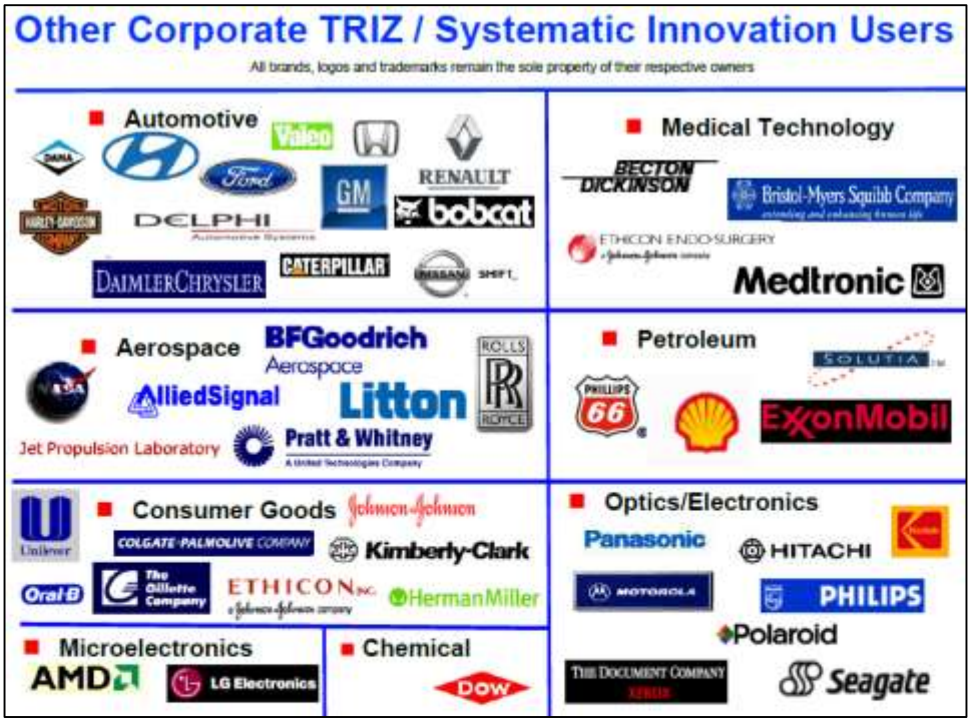
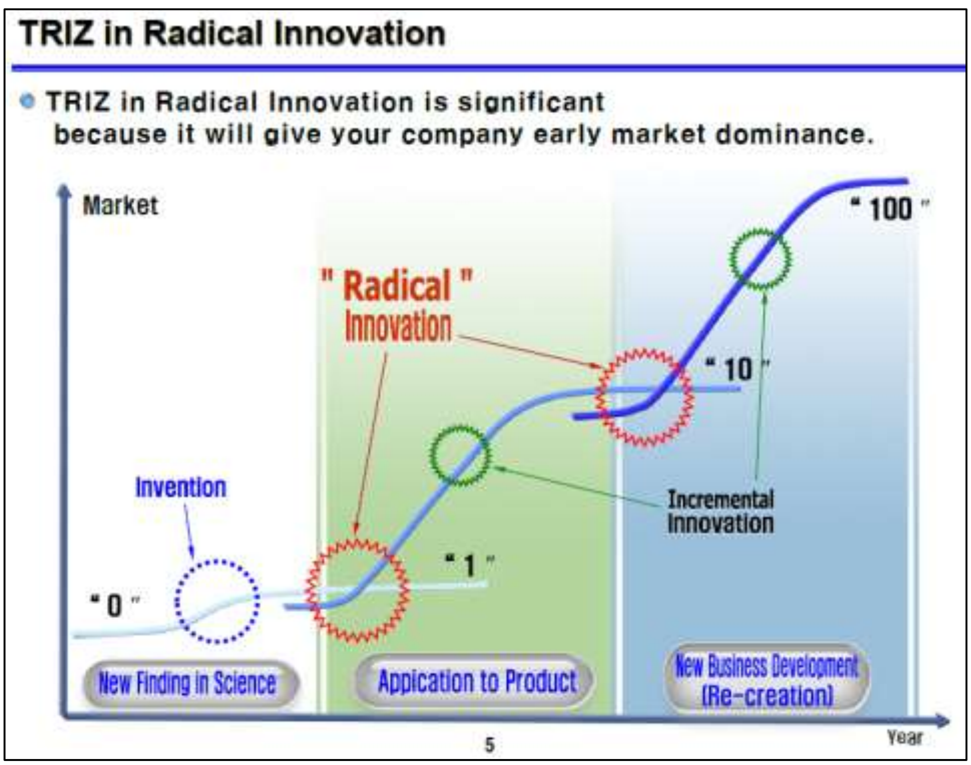


Fig. 7.10: TRIZ Technique adopted by Samsung [660] [662] [663] [667]



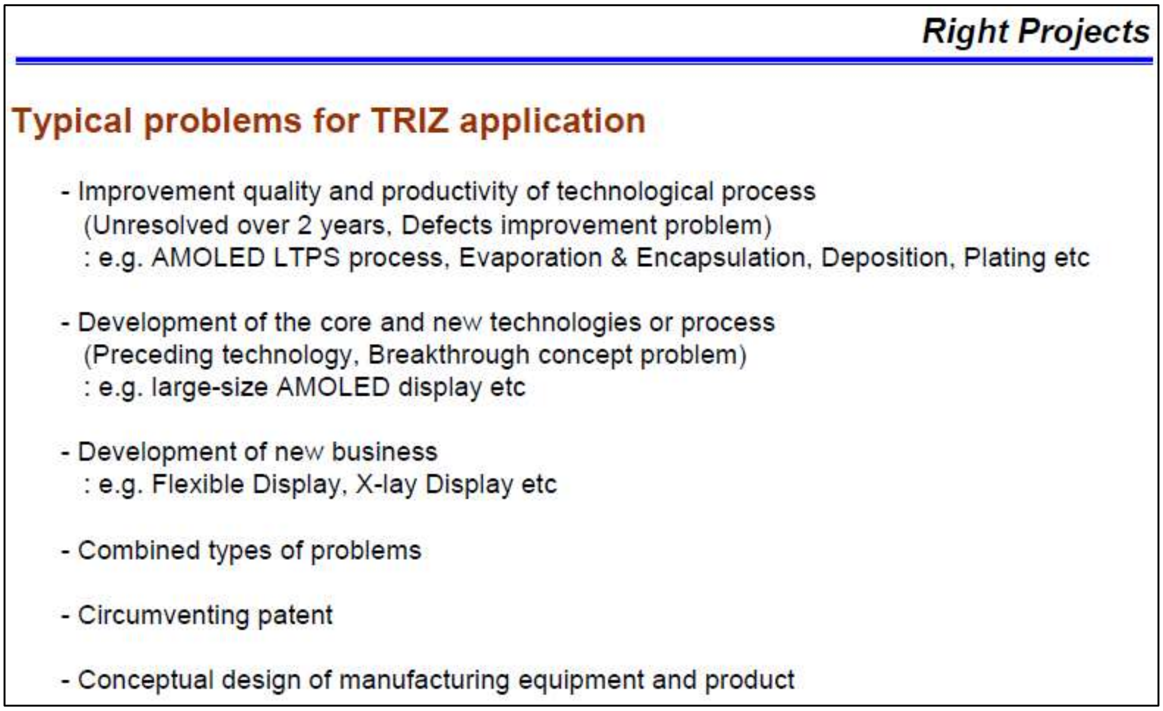


Fig. 7.11: TRIZ experiences at Samsung Mobile Display [664]

7.11. Guarantee of Increasing the Odds of Innovation

As such, what training in innovation provides is **not so much a guarantee of becoming the next great innovator**, **but a guarantee of increasing the odds of innovation**. That increase in the odds is not a function of technical information, **but a function of self-perception as an innovator and a function of change in behavior**. That is perhaps the most striking feature of trying to teach innovation in a corporate context: that the specific intention of teaching innovation management has to be behavior and cognition change – focused on the development of perception of self as an innovator. [305]

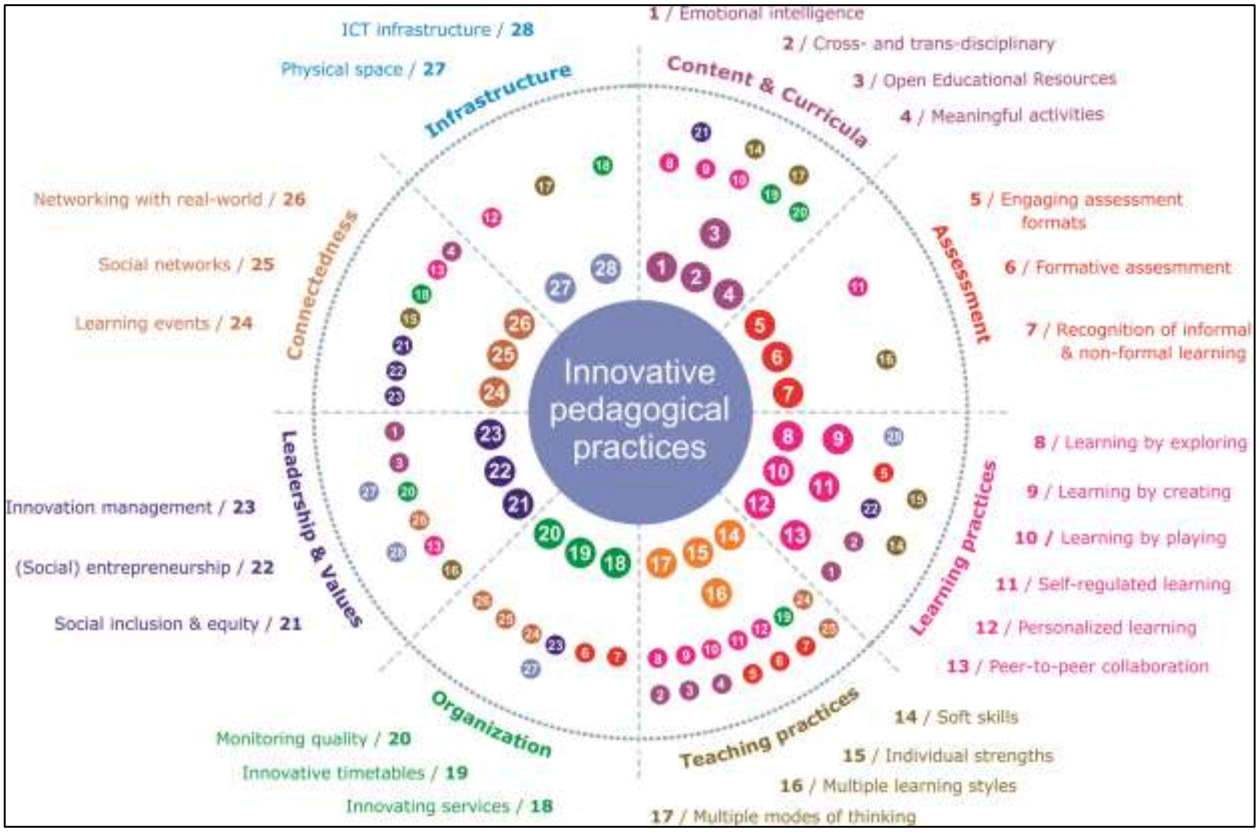


Fig. 7.12: Innovative Pedagogical Practices [331]

Chapter 8: Ways to Introduce Innovation in University System

*"An important focus area is the **role of innovation in higher education**. While several policy initiatives have been taken in this area, these need to be implemented effectively to revitalize and boost the higher education framework in the country…This kind of flexibility will create an environment conducive to **innovation** and promote **inter-disciplinary** approaches." President of India Hon. Pranab Mukherjee [74]*

*Universities and higher educational institutions are expected to **lead and set the innovation agenda** – especially in developing people with the necessary skill sets, background and attitudes to solve local, national and global problems. Universities and Institutes in India face several challenges in the changing global scenario. Can Indian universities be the **catalysts for innovation** in the Indian economy? How can we create an **enabling environment** in our universities that facilitates innovation? How can universities play a role in **developing innovation ecosystems** in their local areas/ regions? How do we build vibrant linkages between universities and industry, government and other societal entities? [34]*

*Paul Graham, the Co-Founder of Y Combinator, USA stated that "**There are no technology hubs without first rate universities**…if you want to make a Silicon Valley, you not only need a university, but one of the top handful in the world." He goes on to specifically name Stanford University. [669]*

8.1. Ways to Introduce Innovation in University System

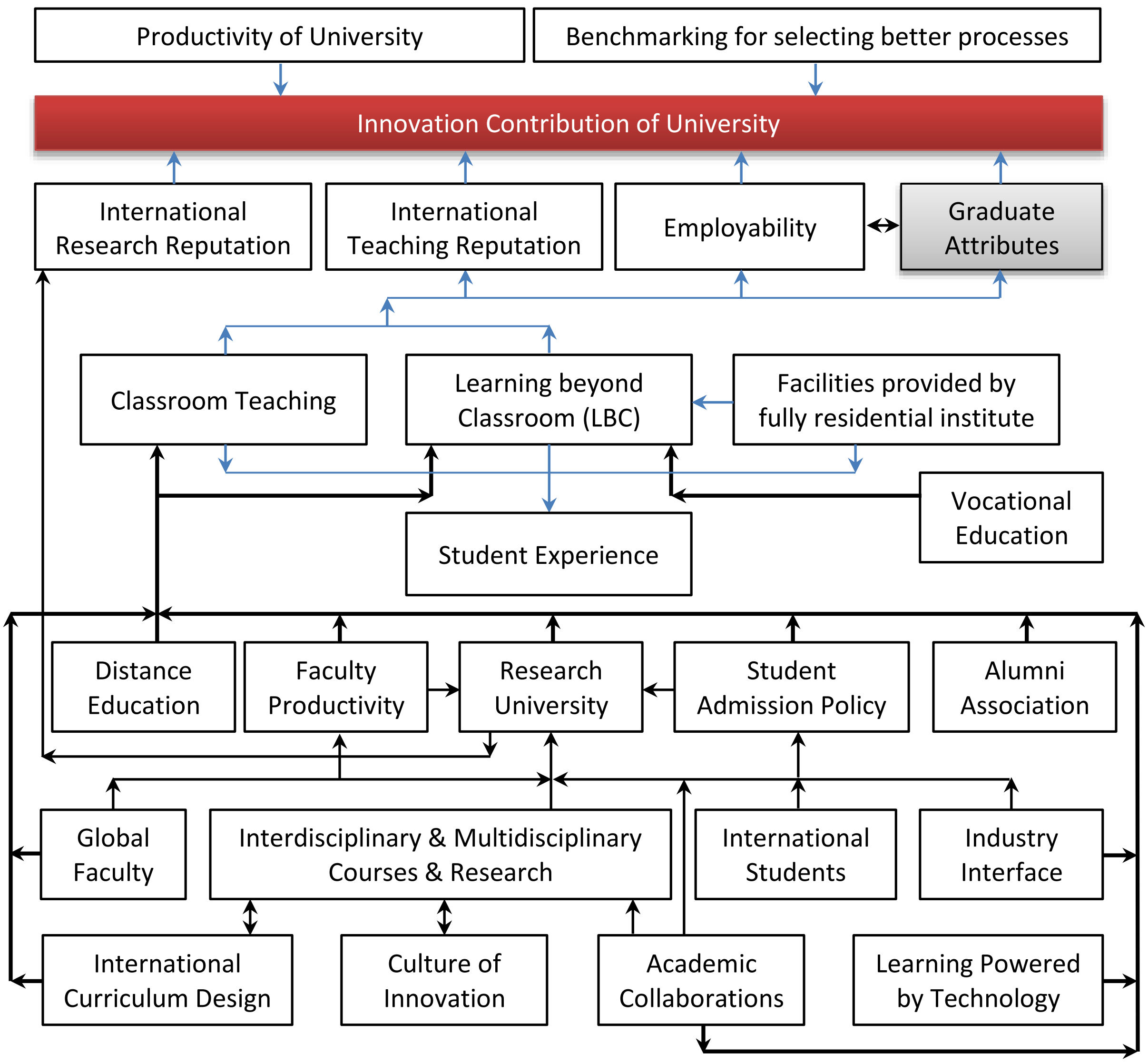


Fig. 8.1: Innovation Contribution of University depends upon number of Interdependent factors

Almost every aspect mentioned in above diagram has been covered in my previously published series of 5 books on World Class University.

The innovation can be introduced in University for two different purposes.

- **To improve efficiency and effectiveness of the University**: I have discussed this approach along with case studies in Chapter 19 of my book "Strategy to Develop World Class University".
- **For developing Innovative brain and to enhance the Innovation contribution of the University**: This approach is discussed in detailed along with case studies in the following sections.

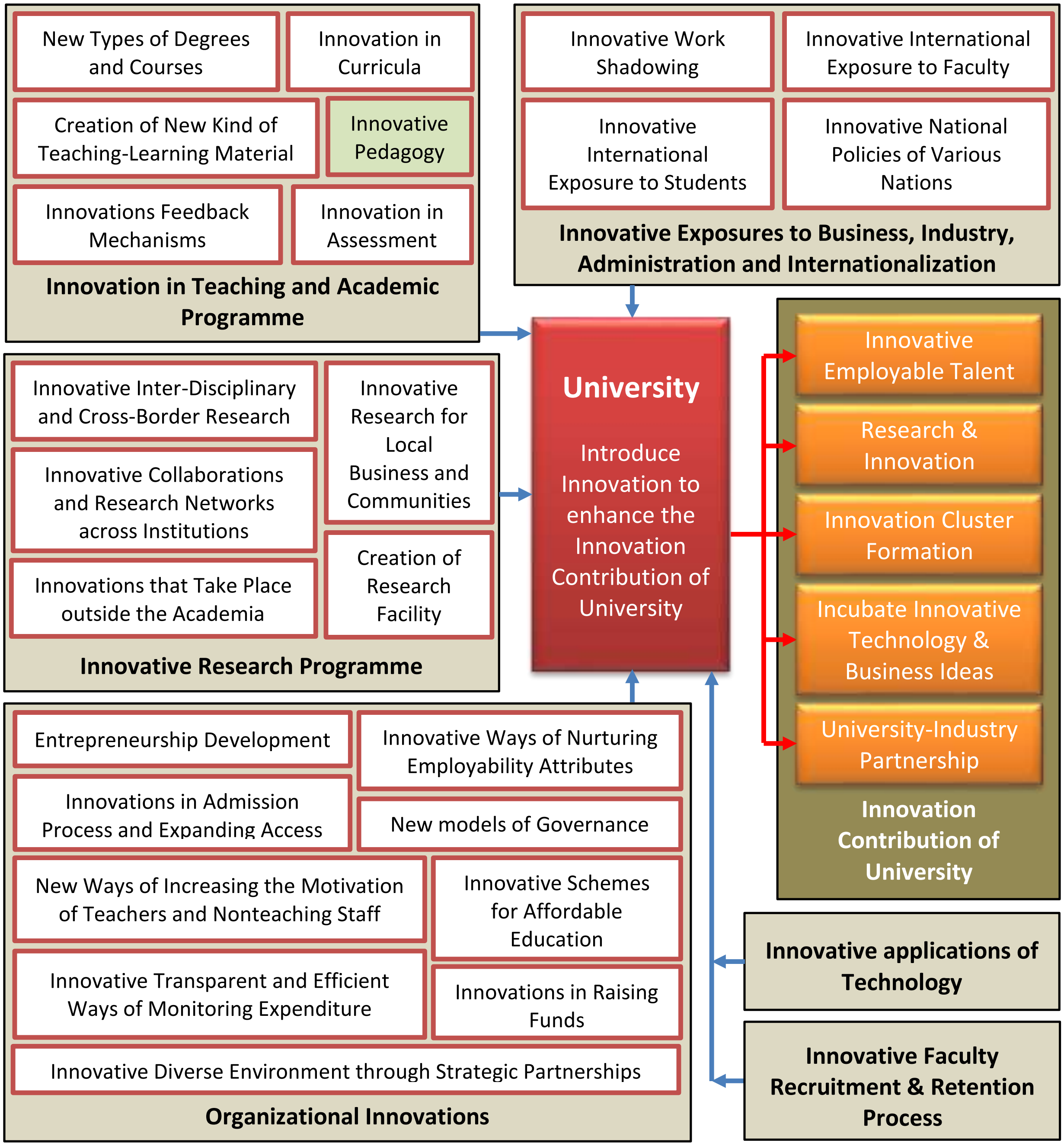


Fig. 8.2: Ways to Introduce Innovation in University System to enhance Innovation-Contribution of University

8.2. Innovative Teaching and Academics Programme

8.2.1. New Types of Degrees and Courses

The new type of degrees and courses can increase the University-Innovation-Contribution. The options are:

- Interdisciplinary degree or courses
- University-Industry partnerships for joint degree programs or courses
- Joint degree programs by many universities

- In the US, a new interdisciplinary degree called Professional Science Masters (PSM) has been gaining ground. The objective of PSM is to professionalize sciences, social sciences, and humanities degrees to produce graduates with both disciplinary expertise and business skills. Within a decade of its launch, more than 100 universities are offering PSM degree. Dean David King of the State University of New York (Oswego) said, “It’s interdisciplinary. It’s a hybrid, which I think is more agile. It’s responsive to rapidly changing needs in terms of the job market”, in a recent New York Times article.
- More recently, some of the best B-schools have been working to integrate interdisciplinary curriculum and research in their offerings. For example, Dartmouth’s Tuck School of Business launched an interdisciplinary programme in healthcare. [353]
- Stanford’s Law and Business schools announced creation of an interdisciplinary centre focusing on clean energy technology.
- Brown University partnered with Spain’s Instituto de Empresa (IE) to launch an Executive MBA (EMBA) programme with interdisciplinary liberal arts. [353]

Industry Supported Institutes i.e. Corporate University Model: In this model the courses are in collaboration with industry. The industry provide the Faculty and takes responsibility of few subjects of the course.

- A good example of this is the Retail Academy being established by Coca---Cola and the Indian Business School. According to Ahmet Bozer, Coca---Cola’s Eurasia and Africa President, “The initiative is mainly to bring about a well---rounded retail management training programme to contribute towards the quality of future retail managers.”
- Manipal Education has established an Academy with ICICI Bank to offer courses to bank officers. This is claimed to be the first example of a corporate university model. [31]

- The IBM had been promoting an interdisciplinary field of Service Science, Management and Engineering (SSME) based on the premise that the global economy is increasingly becoming services and knowledge-driven, which requires a unique set of interdisciplinary competencies to innovate in the sector. SSME leverages the strengths of existing disciplines of engineering and management to develop T-shaped professionals who possess deep disciplinary expertise coupled with wide interactional expertise to understand and communicate across a wide range of disciplines and business functions. [353]
- Zensar has exclusively tied up with 13 colleges under its Centres of Excellence (COE) programme where its technical managers actively engage in distance learning modules for third— year engineering students. [388]
- KPIT Cummins, through its PACE programme, creates project banks and sponsors projects for the final year students; conducts special workshops for students at college campuses in soft skills and process related training including basics of six sigma methodology. [388]

- As part of its Educational Institutions Alliance Program, HCL Technologies has launched HCL K2 Academy, which is partnering with universities to train students in contemporary technologies, projects, industry exposure through principal workshops by Microsoft, Oracle and Redhat.
- Amity has such tie-ups with Nokia Siemens and Cisco, while College of Engineering, Pune (COEP) has MoUs with IBM, John Deere and Wipro. Manipal has an academic Alliance with SAP U Academy for SAP Certification and collaboration with Phillips for Bottom of the Pyramid (BOP) project related training. [388]
- Erasmus Mundus Program is a Joint degree program by number European Universities

Additional information on this topic is available in Chapter 8 (Section 8.5) in my book “Washington Accord & Multi-Objective Integrated Model for Developing WCU”.

8.2.2. Innovation in Curricula

The innovation competencies must be implant in the curriculum to enhance the innovation contribution of the university. I have already covered many aspects in previous chapter. I would like to add few more examples over here.

- Graduate Attributes Creativity and Innovation Toolkit of Griffith University Australia provides the details about how to develop the curriculum to enhance innovation competency. I have included few important points about these aspects in previous chapter. [340]
- IIT Gandhinagar (IITGN) Project Based Learning: The Institute emphasizes project based learning both inside and outside the classroom. Our students have undertaken innovative community and commercial projects, from teaching science to students at a neighborhood school, developing a digital walking stick for the blind, building an award-winning machine for making incense sticks and a wheelchair that climbs stairs, to launching a start up on distributed computing through IIT's Incubation Centre. [354]

8.2.3. Innovation in Assessment

The assessment is must for measuring the effectiveness of any process. The teaching is not the exception. Let's see few examples.

A popular textbook used in undergraduate and graduate courses at top universities across the U.S., "Innovate Like Edison" features an innovation self-assessment tool you can use to determine your own innovation strengths and opportunity areas -- or those of your team. Designed to evaluate key facets of Edison's Five Competencies of Innovation™, the assessment determines how you rate on each of the crucial elements, Edison's own process:

- Solution-centered Mindset
- Kaleidoscopic Thinking
- Full-Spectrum Engagement
- Master-mind Collaboration
- Super-Value Creation [373]

8.2.4. Innovative Pedagogy

I have already discussed the '**Innovation Competencies and Innovation Pedagogy**" in previous chapter. I would like to quote few more examples over here.

- The "Student Fund" provides the opportunity for Wharton MBA students to gain hands-on experience in the investment management field that enhances lessons learned in both classroom and work environments. There are around 6000 university-based student-run investment funds in USA. Wharton Investment Management Fund: The Wharton Investment Management Fund is a student-run fund responsible for managing approximately $1 million on the behalf of The Wharton School of the University of Pennsylvania. The Fund is officially managed by twelve Fund Fellows, all of whom are current Wharton MBA students. Each year, the Fund Fellows review over one hundred investment recommendations from Wharton MBA students who act as Fund Analysts. [376]
- It has been found that total time spent on laboratory experiments is only 12.2 percent. Inadequate hands-on training is a major weakness in all institutes. The tinkering and innovation labs, and workshops, should remain open 24/7. But this requires financial resources and manpower, which is a scarcity in the country. Some believe institutions should consider setting up programmes such as the "Practice School" in BITS Pilani where students and faculty get involved with professional work (from the industry) for 7.5 months. [386]

8.2.5. Creation of New Kind of Teaching-Learning Material

The teaching-learning material can boost the creativity and innovation. Let's consider few examples.

- The 3D Human Anatomy is the wonderful teaching learning software for medical students. It shows three dimensional images of any part of the human body, which you can rotate in any direction, enlarge or reduce the image and visualize the inner part by hiding the upper one.

Fig. 8.3: Enhancing Innovative Competencies: Teaching Students at Oklahoma State University, USA [519]

8.2.6. Innovations in Teaching and Other Feedback Mechanisms

To enhance the efficiency of any process the strong feedback corrective mechanism is very helpful. I would like to quote few examples in this section.

Purdue University has developed and is pilot testing several "Studio Projects" that assess student learning

- Hotseat is a social networking application that allows "students to provide real-time feedback during class and enables professors to adjust the course content and improve the learning experience." Students can use Twitter, Facebook, text messaging, and the Hotseat Web Application to access classroom discussions.
- The Course Signals platform is a real-time feedback application that "detects early warning signs and provides intervention to students who may not be performing to the best of their abilities before they reach a critical point." [378]

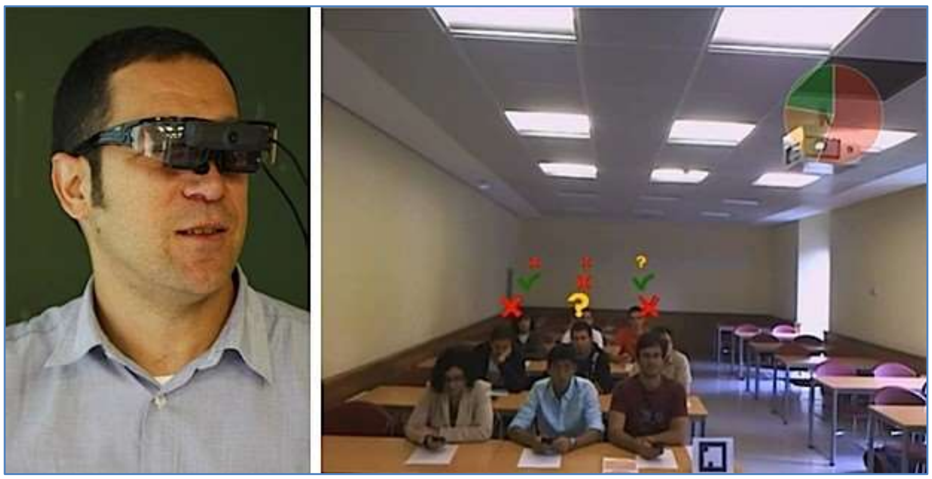


Fig. 8.4: La Universidad Carlos III of Madrid: Augmented Reality based Real-time Student Feedback System [529]

8.3. Innovative Research Programme

8.3.1. Innovative Inter-Disciplinary and Cross-Border Research

The Interdisciplinary, Multidisciplinary and Transdisciplinary culture can enhance the innovation contribution of the university. This aspect is covered in this section with the help of few examples.

- Washington University's Olin Business School and the College of Architecture: What happens when you put some highly creative architecture professors in an art studio with some intensely quantitative business professors and ask them to solve a problem? This hybrid approach to problem solving will be the focus of a new interdisciplinary executive education seminar taught by faculty members from Washington University's Olin Business School and the College of Architecture. "We are taking advantage of how different disciplines within the university approach and solve problems," explains Panos Kouvelis, Senior Associate Dean and Director of Executive Programs at Olin.
- Washington University's School of Engineering & Applied Science and Olin: Olin's executive education program is launching another interdisciplinary course this fall on energy procurement and risk management. Offered by Washington University's School of Engineering & Applied Science and Olin, the two-day program will involve a live case study and audit of a building's energy use, environmental impact and sustainability from a profit and loss perspective. "Scientists don't necessarily think about the business aspect when designing or inventing things," says Chun, who will co-teach the course with John Murphy, research associate at the School of Engineering & Applied Science. "We [business professors] think about the cost and benefit, the economics of the business model, but we don't always ask deeper questions about the macro view." Chun says engineers bring an excellent macro view to problem solving and, together with the business professors, will be able to build a good business case for energy management. [379]

8.3.2. Creation of Research Facility That May Be Useful To Other Universities & Organizations

The research collaboration can enhance the innovation contribution of the university, which is covered in this section with the help of few examples.

- The Indian Institute of Technology in Bombay can serve as an inspiration to other institutions in the country. It has done extremely well in attracting corporate sponsorship of its labs. These include the Xilinx FPGA Lab; the Tata InfoTech Lab; the Intel Microelectronics Lab, the Texas Instruments Digital Signal Processing Lab; the Wadhwani (Alumni) Lab and the Cummins Engine Research Lab.
- The Aditya Birla Group formally launched the Aditya Birla Science and Technology Company (ABSTC) outside Mumbai in March 2012. Rajiv Dube, the R&D Centre's Director says, "Yesterday's business had R&D centres for each business in each country. For today's business we will establish a link with major labs across the world for free transfer of knowledge from one lab to another."

8.3.3. Innovative Collaborations and Research Networks across Institutions

The collaboration is one of the most important driver for enhancing innovation contribution of the university. The few examples are:

The Mediterranean Innovation Alliance, or MEDINNOALL is an European project links universities to boost innovation project. This project aimed to promote research and development as well as technology and industrial upgrading. The MEDINNOALL project worked to promote innovative thinking in higher education in the Mediterranean and strengthen the ability of universities to collaborate and conduct research. Co-financed by the European Union (EU) in the framework of the TEMPUS IV programme, the MEDINNOALL consortium comprised five European partners – four universities and a chamber of commerce – and 12 universities and four business associations in four of the North African countries. It has been supported by the Federation of Egyptian Chambers of Commerce, the Ministry of Education of Morocco and the Ministry of Higher Education, Scientific Research and Technology in Tunisia. [380]

IBM Research gives grants to universities as part of its Shared University Research (SUR) program, to support research in high computing and networks. They have over 100 universities, including NITs and IITs, in their University Relations program. “The aim is to expose students to challenging research problems and get them interested so that they are motivated to pursue a fulfilling career in the field.” [31]

8.3.4. Innovations that Take Place Outside the Academia

The section covers the innovative task, which is outside the academia, for enhancing innovation contribution of the university.

- The BITS’ WILP (Work Integrated Learning Programmes) is an off-campus education extension program developed for working professionals and offered collaboratively with the industry. This is an innovative two way industry interface for research, teaching and revenue generation, which had helped a lot for developing self-sustainable model of BITS.
- Recently, seven engineering colleges from Bengaluru and Hyderabad collaborated to prepare a payload for ISRO’s RH200 rocket space launch,” says Madan Lal, president of Institution of Engineers (India). [387]

8.3.5. Innovative Research for Local Business and Communities

The R&D is one of the main driver for product innovation. Thus R&D initiatives and investments give boost to Innovation.

> Catawba College (N.C.): Through its on-campus laboratory, CARL (Catawba Analytical Research Laboratory), Catawba College (N.C.) has conducted chemical analysis and research projects for area businesses. Businesses paid a fee for students to conduct company research using state-of-the-art equipment and techniques. [381] [382]

8.4. Organizational Innovations

8.4.1. Entrepreneurship Development

For innovation the two most important factors are creativity and entrepreneurship. Now a days the entrepreneurship training is very common and provided in most of the leading universities in India and abroad.

8.4.2. Innovative Diverse Environment through Strategic Partnerships

The diversity is one of the most important driver for innovation. It can be build up through collaborations and strategic partnerships. Most of the leading universities in India and abroad are signing MOU with many industries and universities of international repute. I have quoted many examples in my book "Strategy to Develop World Class University".

8.4.3. Innovations in Admission Process and Expanding Access

The admission process plays vital role to attract global talent. If student is talented then it is easy to develop innovation competencies.

> Lebanon Valley College: Run a "half-off" sale on tuition. Lebanon Valley College (Pa.) a liberal arts school began a discount program 17 years ago, amid predictions that lowering tuition would lead to financial ruin. To the contrary, an internal study revealed that revenue rose 113 percent, while costs increased only 9.6 percent since launching the program. Known as the Presidential Scholarship Program, students in the top 10 percent of their high school graduating class receive a half-off tuition scholarship; those in the top 20 percent get one-third off tuition; and those in the top 30 percent receive one-quarter off. [382]

Boston University Boosted enrollment through a distance learning division: The Boston University Division of Extended Education serves nearly 3,000 enrolled students in undergraduate, graduate, and professional development programs. Its criminal justice master's degree is the most popular program of its kind in the world; enrollments grew from 45 to more than 400 in three years. The school's distance-learning programs are an important revenue source, grossing $15 million per year, more than making up for enrollment fall-off in part-time, on-campus night and weekend courses. [381]

8.4.4. Innovative Ways of Nurturing Employability Attributes

Many employability attributes are nothing but innovation competencies. The detailed information is available in chapter 9 of my book "Strategy to Develop World Class University".

8.4.5 New Ways of Increasing the Motivation of Teachers and Nonteaching Staff

The motivation is one of the most important driver of innovation. It is also very important while developing innovation competencies.

Normally the examples under this category are based on research incentives or other incentives. Every leading institute has adopted some technique to motivate and retain the staff members. I found that Thapar Institute has adopted good practices.

8.4.6. New models of Governance

The leadership and good governance are the most important drivers for innovation. In the new model of governance many institutes adopted new approaches for delegation of power; decentralization of financial authorizes, enhanced the efficiency, transparency and accountability of the processes and discouraged conflict of interest.

Today, 19 of the top 20 American universities in US rankings are controlled by alumni (defined as 50% or more representation on the Board of Trustees). The only exception, the California Institute of Technology, has a board with 40% alumni representation. Of the top five, three (Harvard, Yale, and Columbia) are managed entirely by alumni, and two (Princeton and Stanford) are under 90% alumni control. Alumni run the show even at public institutions such as Purdue (90%) and Michigan (63%). On average, alumni make up 63% of the boards of the top 100 US universities, both public and private. [383]

The European Credit Transfer and Accumulation System (ECTS) has been designed with such a goal—to create the truly international student. Through the system, a student can start his programme in one university and move to another (either temporarily, or permanently) through lateral admission in order to avail either a better, or a more specialized and suitable programme. The system also allows a student to study at a specialist school (perhaps far from home) and then return either to her home town, or closer home, to finish the rest of the course. [389]

8.4.7. Innovations in Raising Funds

I have described hundreds of innovative techniques of revenue generation and fund raising in my book namely "Funding Techniques of World Renowned Universities" by Shroff Publications.

Manipal University and Sikkim Manipal University are significant and well respected private university brands in India. Within the Manipal Education Group is a company Manipal Universal Learning (MUL) which provides services to the two universities. The services MUL provides Sikkim Manipal University are a £38m turnover business. MUL is an Indian university group that attracted $70m of private equity (from IDFC and Capital Partners from the US) investment in 2007. In other words, a private company is providing services at a profit to students via accreditation granted by a State Government. [31]

8.4.8. Innovative Transparent and Efficient Ways of Monitoring Expenditure

For every development processes need the strong financial background and thus along with revenue generation, the expenditure monitoring is also important. I have described hundreds of innovative techniques of cost saving and monitoring in my book namely "Funding Techniques of World Renowned Universities" by Shroff Publications.

8.4.9. Innovative Schemes for Affordable Education

Let's see few technique, which can help to attract best talent from all strata of the society. Best talent is always required to promote innovation in the University.

- Thapar University does not recover its expenses from students' fees, which isn't surprising considering that the university offers scholarships to one out of every four students in keeping with Thapar's pledge to turn away no seeker of knowledge. The university has also committed to limiting fees while continuing to offer the best compensations to faculty in a quest to measure up to the highest global standards. According to Dr. Abhijit Mukherjee, Director, Thapar University, "The world's top universities have huge endowments and recoup only a fraction of their budget from students. We are miles away. Yes, our budget has increased by six times in the past six years but our philanthropic mission precludes us from raising fees in the same proportion." Research grants and contributions from the Thapar Education Trust help plug the shortfalls. [384]
- College of the Ozarks: Help students earn their education. College of the Ozarks (Mo.) offers its students a debt-free education in exchange for participating in its work program. The institution guarantees 100 percent of tuition covered, if a student completes 15 hours of work each week and two 40-hour work weeks per year at one of 80 campus work stations. With the help of student labor, College of Ozarks is able to function with fewer staff than normal, in areas such as maintenance, cafeteria, and office help. Additionally, several campus work stations create different products that are sold to the public. Students operate a water-powered grist mill that produces stone-ground flours and baking mixes. They also run a Fruitcake and Jelly Kitchen and The Keeter Center, a lodge, restaurant, and conference center. Other student industries include a processing plant, weaving and pottery studio, and stained glass department. [381]

8.5. Innovative Exposures to Business, Industry, Administration and Internationalization

8.5.1. Innovative Work Shadowing

The innovation happens at the point of production. Thus the student must have various type of industry exposure like Work Shadowing, industrial training etc.

IIT Gandhinagar (IITGN) Junior Fellowship: The fellowship offers opportunities for graduating students to gain exposure in less conventional work prior to making career decisions. Under this scheme, typically for one year duration, the Institute helps fresh graduates explore unconventional career options through attachments with senior government officials, working with NGOs, or experience in educational Institutions, prior to finalizing their career decisions. Currently, four recent graduates are availing this opportunity: three students interested in political and administrative life are working under the tutelage of senior IAS officers and one interested in the social sector is working at IITGN to develop technology to improve the incomes of women in slums. [354]

8.5.2. Innovative International Exposure to Students

The collaboration is one of the main driver for innovation. Thus the international exposure is must for students to enhance the collaborative atmosphere.

IIT Gandhinagar (IITGN) India-ki-Khoj: IITGN has developed a unique two-week cultural immersion programme titled India-ki-khoj for undergraduate students from across the world to discover India. The December 2011 programme attracted 10 undergraduates from Caltech and 10 IITGN students. [354]

Stanford University Global Management Immersion Experience (GMIX): How can you change the world if you don't understand it? Participating in a Global Experience is a requirement of the Stanford MBA Program.

- Global Study Trips: Develop a meaningful, on-the-ground perspective of the business, political, and social climates within a country during a Global Study Trip. Prior to the trip, you'll hear from and host speakers on topics such as macroeconomic policy or political history and facilitate discussions on history, culture, and business etiquette. You'll travel with about 30 classmates and a faculty advisor and have unprecedented access to business, government, and nonprofit leaders with whom you'll explore the complexities of global management. When you return home, you'll share your experiences and key takeaways with the Stanford GSB community.
- Social Innovation Study Trips: Get to know another country, it's people, and organizations through the lens of a social or environmental theme (such as education, healthcare, climate change, or economic development). During a Social Innovation Study Trip, you'll see the impact of social and environmental issues on the people most affected by them. You will travel with 22 classmates as you integrate into your learning the perspectives of thought leaders from for-profit, government, philanthropic, and nonprofit organizations. Conduct a meaningful, short-term project with one of your in-country hosts that furthers their mission and your team's learning goals. After the trip, you can dig deeper into trip topics with a faculty-guided independent study project or project funding and travel support from the Center for Social Innovation. [630]

8.5.3. Innovative International Exposure to Faculty

The faculty is mainly responsible for developing innovation competencies of the students. Every nation is trying to develop some system to enhance the innovation competencies. Thus the faculty must have enough international exposure.

The IITGN has implemented extremely liberal norms for granting one year leave to a new faculty (for example, within a semester of joining the Institute) for international post-doctoral research opportunities. [354]

8.5.4. Innovative National Policies of Various Nations

The Innovation Ecosystem is regulated through the government policies and thus it's the important issue.

The Chinese government started the Thousand Foreign Experts program, which is designed to attract up to 1,000 foreign academics and entrepreneurs over the next 10 years to help improve research and innovation. It has already attracted more than 200 applicants from countries like the United States, Japan and Germany, according to a report in February by Xinhua, China's official news agency. The program is an extension of the Thousand Talent program, which started in 2008 as a way to attract experts, academics and entrepreneurs to China. While 1,600 experts — more than half of them academics — came to China under that program, most were Chinese-born, said Mr. Wang, an adviser to the government on its talent policy. [385]

8.6. Innovative Faculty Recruitment & Retention Process

Number of innovative recruitment processes for attracting global talent (faculty) have been discussed in my book "Strategy to Develop World Class University".

8.7. Innovative Applications of Technology

The Technology is one of the main driver for Innovation. I would like to introduce few points and examples through figures to highlight this issue, which I have already described in my book namely "Technology-Storms Redefining World Class Universities". Hundreds of such innovative technology applications have been discussed in this book.

Fig. 8.5: Technology Enhanced Learning [511]

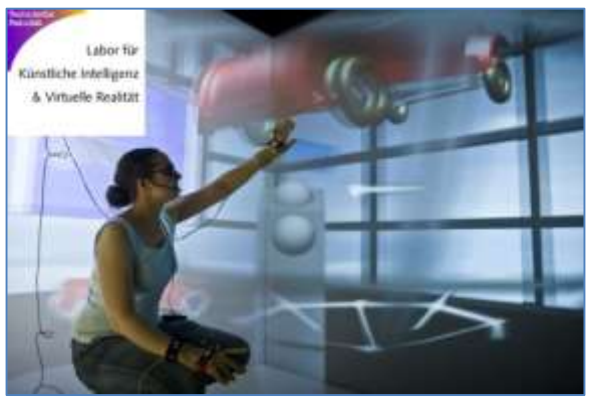


Fig. 8.6: Bielefeld University: VR Lab to boost creative thinking [513]

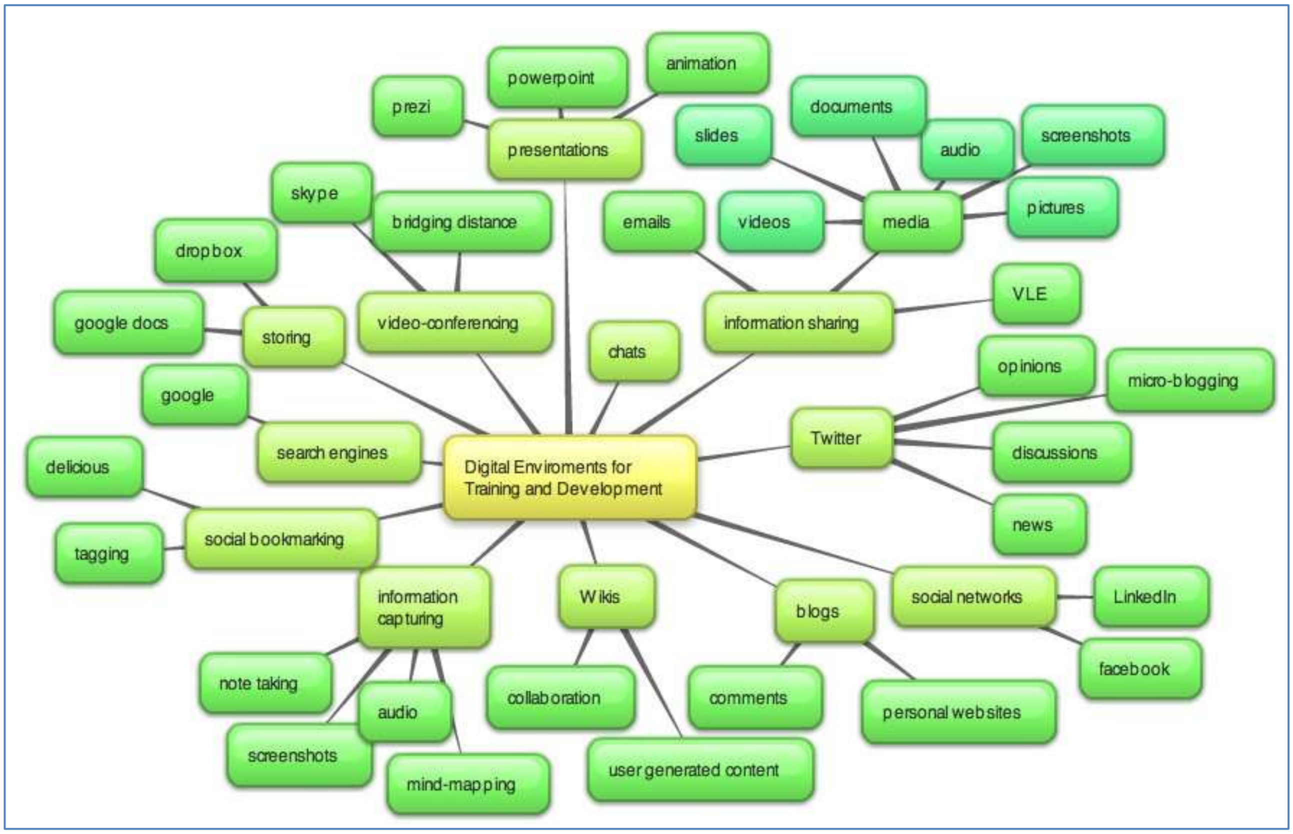


Fig. 8.7: The 21st Century Digital Environment for Training and Development [512]

Fig. 8.8: Interactive Whiteboards (IWBs) and Smart Boards for Teaching & Learning to develop the Creativity and Innovation

Fig. 8.9: Creative Use of Technology in Teaching Learning Environment: CAREN Virtual Reality based Medical Instrument for Disabled persons at the University of Groningen [517]

Fig. 8.10: Creative Use of Technology in Teaching Learning Environment: CAVE-2 virtual environment for Neurosurgeons at College of Medicine University of Illinois Chicago (UIC) [514] [515] [516]

Fig. 8.11: Enhancing Innovative Thinking: Virtual reality environments for training of Doctors [518]

Fig. 8.12: Enhancing Innovative Competencies at Washington State University: Virtual Reality and Computer Integrated Manufacturing Laboratory [520]

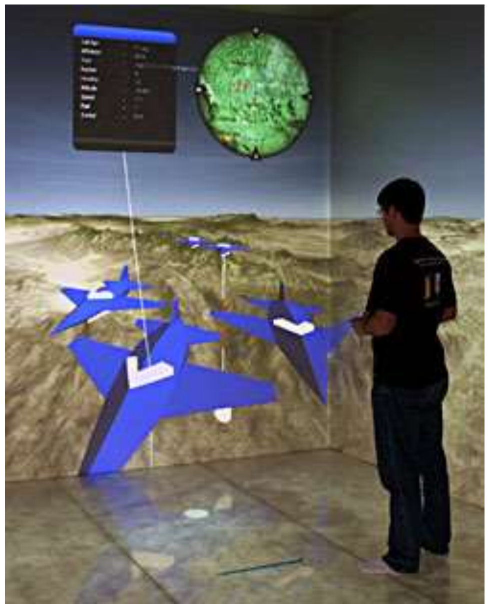


Fig. 8.13: Enhancing Innovative Competencies at Iowa State University: C6 VR Room [521]

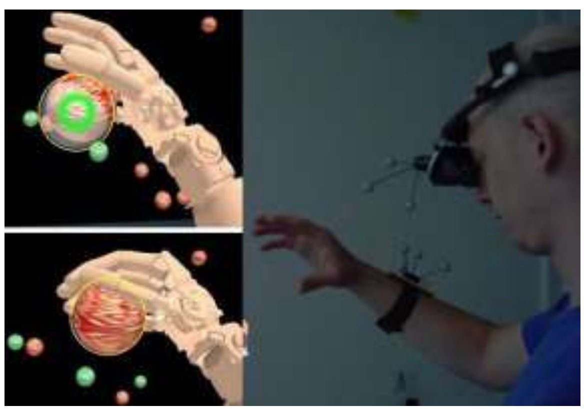


Fig. 8.14: Creative Use of Technology in Teaching Learning Environment: Vienna University: Virtual Reality Training for Upper Limb Prosthesis Patients [522]

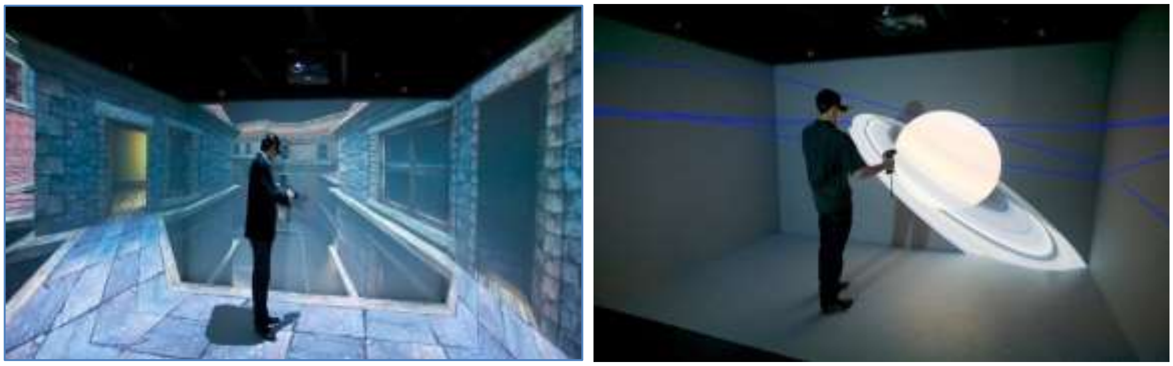


Fig. 8.15: Enhancing Innovation Capabilities at Canadian University Virtual Reality [525]

Fig. 8.16: Enhancing Innovation Capabilities at University of Northampton: NVision Centre [523]

Fig. 8.17: Enhancing Creativity and poser of imagination at University of the Western Cape: Department of Applied Geology VR Hub [524]

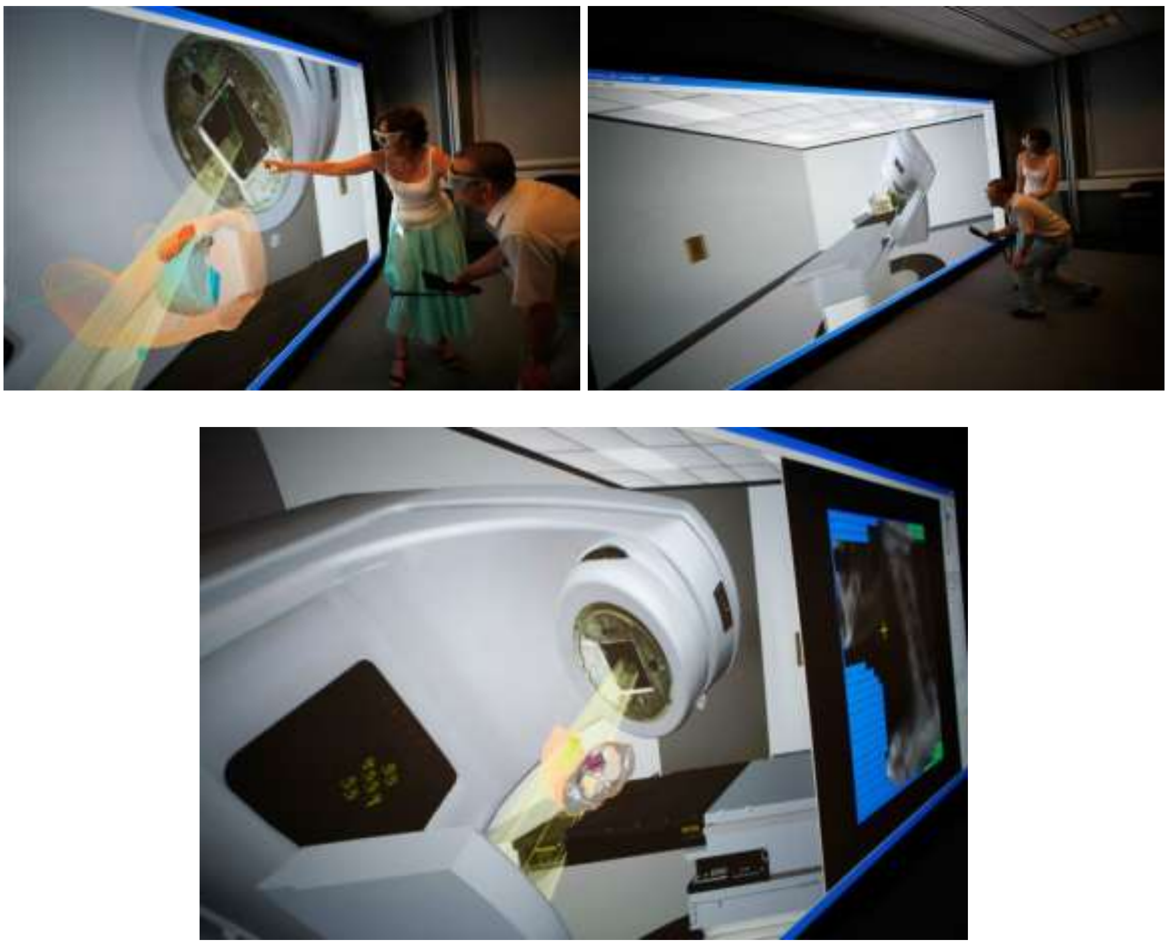


Fig. 8.18: Creative use of technology for teaching at London South Bank University: VR Training for Radiotherapy for Cancer Treatment [526]

Fig. 8.19: Innovative training at Heinz Nixdorf Institute, Germany: HD Visualization Centre [527]

Fig. 8.20: Microsoft Kinect an Augmented Reality application [528]

Fig. 8.21: The University of Southern Mississippi: Augmented Reality in Training Activity [530]

Fig. 8.22: IBM INNOV8 BPM (Business Process Management) Game [531] [532] [533] [534]

Fig. 8.23: IBM INNOV8 BPM: business Architecture heat map & business modeling tool [534]

Fig. 8.24: Simulated dental learning environment at UK Dental Colleges [535]

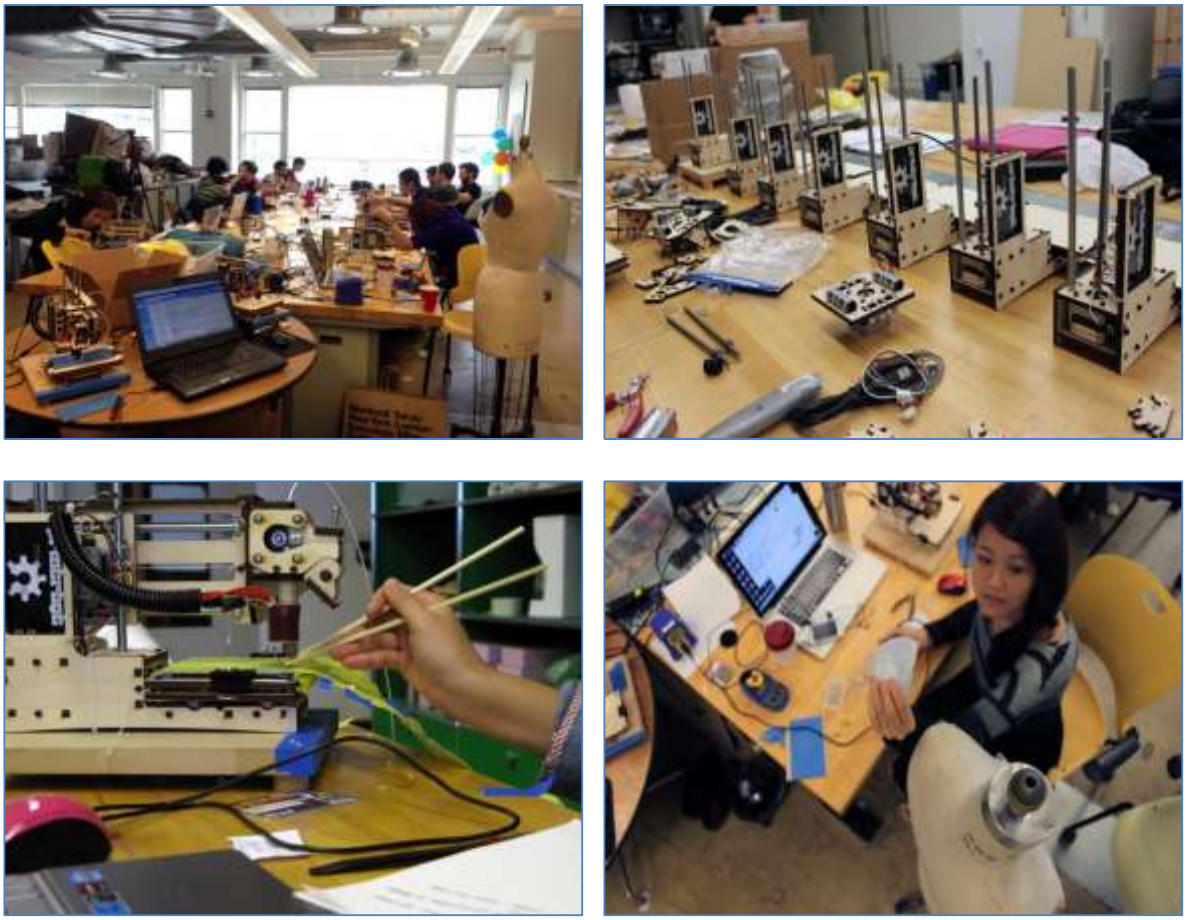


Fig. 8.25: School of Art Institute, Department of Architecture, Chicago: 3D Printer Lab [536]

Fig. 8.26: UVA – SEAS: 3D Printer for Mechanical Engineering [538] [539]

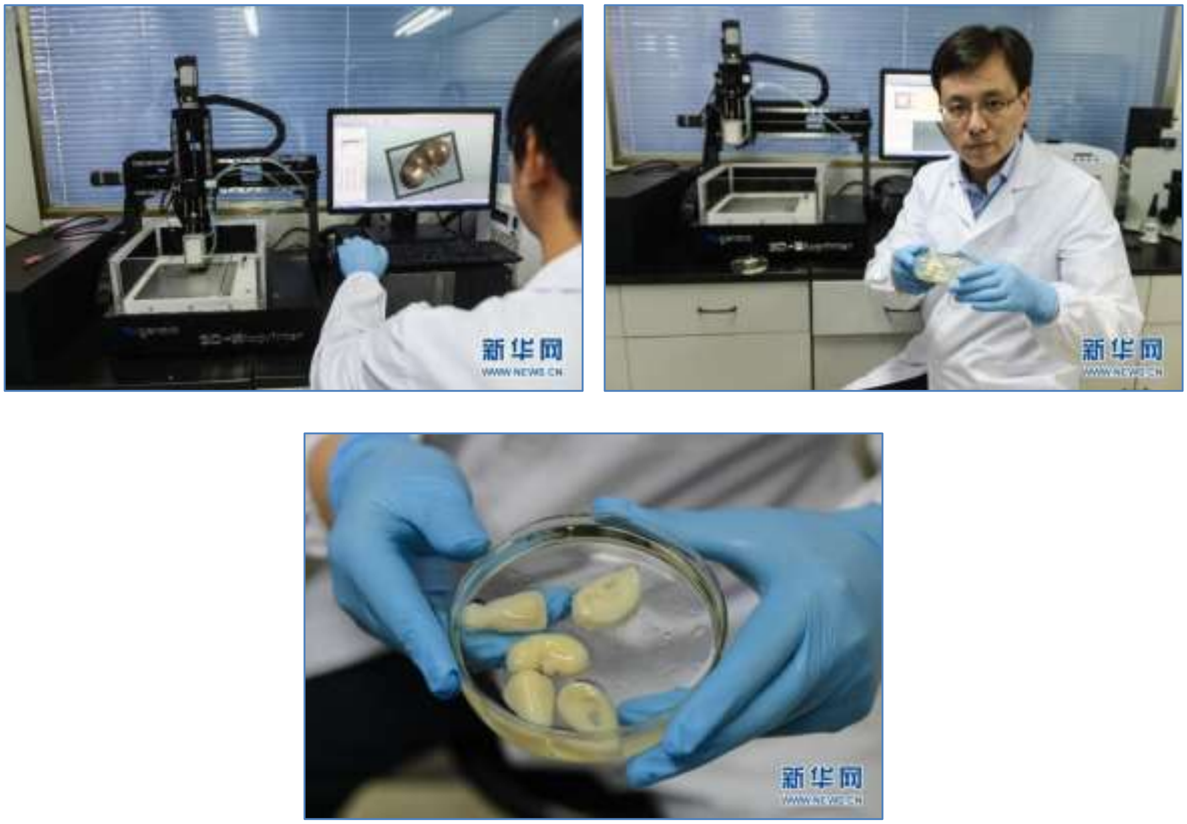


Fig. 8.27: 3D Bio-Printer by Hanghou University China [539]

Fig. 8.28: Victoria University of Wellington, New Zealand: Exoskeletal Cast [540]

Fig. 8.29: 3D Printer at Kobe University for diagnose cancer [541]

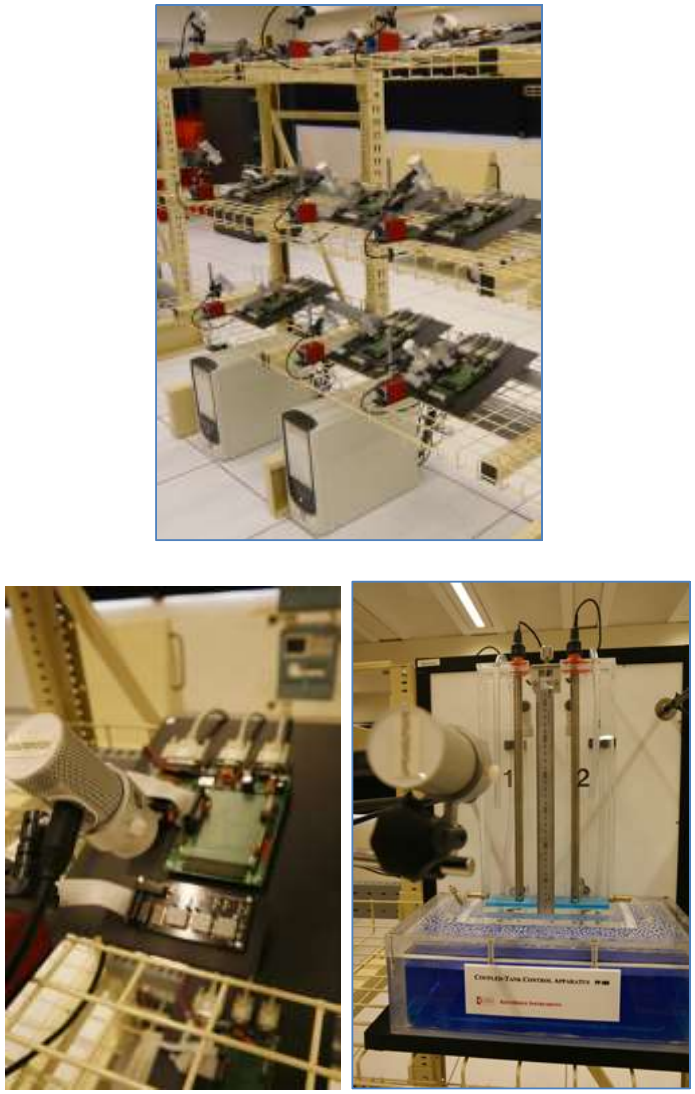


Fig. 8.30: Remote Laboratory at University of Technology, Sydney Australia (UTS) [542]

I have covered hundreds of such technologies and examples in my book "Technology-Storms Redefining World Class Universities". Refer it for more detailed information.

Part III: Analysis of Indian Innovation Ecosystem: Many Islands of Excellence, Plenty of Innovative Brains but Weak National Innovation Ecosystem

Need Special Attention to Growth of Industrial R&D and Innovation for GDP Growth

"Just as oxygen is the lifeblood of living organisms, I think innovation is the driving force behind a successful economy. For too long, under the license raj system, India's innovators were stifled by its protectionist bureaucracy and red tape. But as India increasingly becomes a significant player in the global village, it is the ability of Indians to deliver frugal innovations at global scale that can become the nation's true comparative advantage..." Anand Mahindra, Chairman, Mahindra Group [400]

Chapter 9: Innovation Index, Ranking & Surveys: Status of India not Satisfactory

Where We Stand? What's the International Scenario? India is Lagging Behind? India Needs Effective Innovation Ecosystem

9.1. Global Innovation Index (GII) 2014: India at 76th Position

The Global Innovation Index (GII) 2012 was released by France-based international business school of Cornell University INSEAD and World Intellectual Property Organization (WIPO), a specialized agency of the United Nations, along with the Confederation of Indian Industry (CII). The Index ranks 141 countries/economies on the basis of their innovation capabilities and results.

In the recently released Global Innovation Index (2014), India slipped 10 ranks to the 76th place in 2014 from 2013. It is also the only country among the BRICS nations to have witnessed a decline in the rankings. On the other hand, India also performed poorly in the GIPC IP Index released in January 2014. It has now become imperative to measure the country's poor performance against the global standards. [63]

The Indian Innovation Ecosystem need special attention. Reflecting India's overall struggles with enhancing innovation output, India slipped two positions on the Insead / WIPO Global Innovation Index in 2013. **India's biggest weaknesses are in the institutional environment, and in higher education and R&D.** [29]

India ranked in the middle of GII 2012 with a rank of 64 out of 141 countries. India's rank remained virtually unchanged from 2011 to 2012. Apart from the GII itself, the GII methodology involves the computation of three other indices – an innovation output index, an innovation input index, and an innovation efficiency index. India was ranked 40, 96, and 2 respectively on these three measures in 2012. The innovation input index rests on five pillars:

- Institutions
- Human capital and research
- Infrastructure
- Market sophistication
- Business sophistication

The innovation output index consists of knowledge and technology outputs and creative outputs. The innovation efficiency index is based on the ratio of innovation output to innovation input. [38] [39] [40] [41] [42]

Year	Global Innovation Index (GII) Position of India
2011	62
2012	64
2013	66
2014	76

Table 9.1: Global Innovation Index

Global Innovation Index (GII) 2014	Country	Score
1.	Switzerland	64.8
2.	UK	62.4
3.	Sweden	62.3
4.	Finland	60.7

5.	Netherland	60.6
6.	USA	60.1
7.	Singapore	59.2
8.	Denmark	57.5
9.	Luxembourg	56.9
10.	Hong Kong	56.8
11.	Ireland	56.7
12.	Canada	56.1
13.	Germany	56.0
14.	Norway	55.6
15.	Israel	55.5
16.	South Korea	55.3

Table 9.2: Global Innovation Index 2014: Top 15 countries [69]

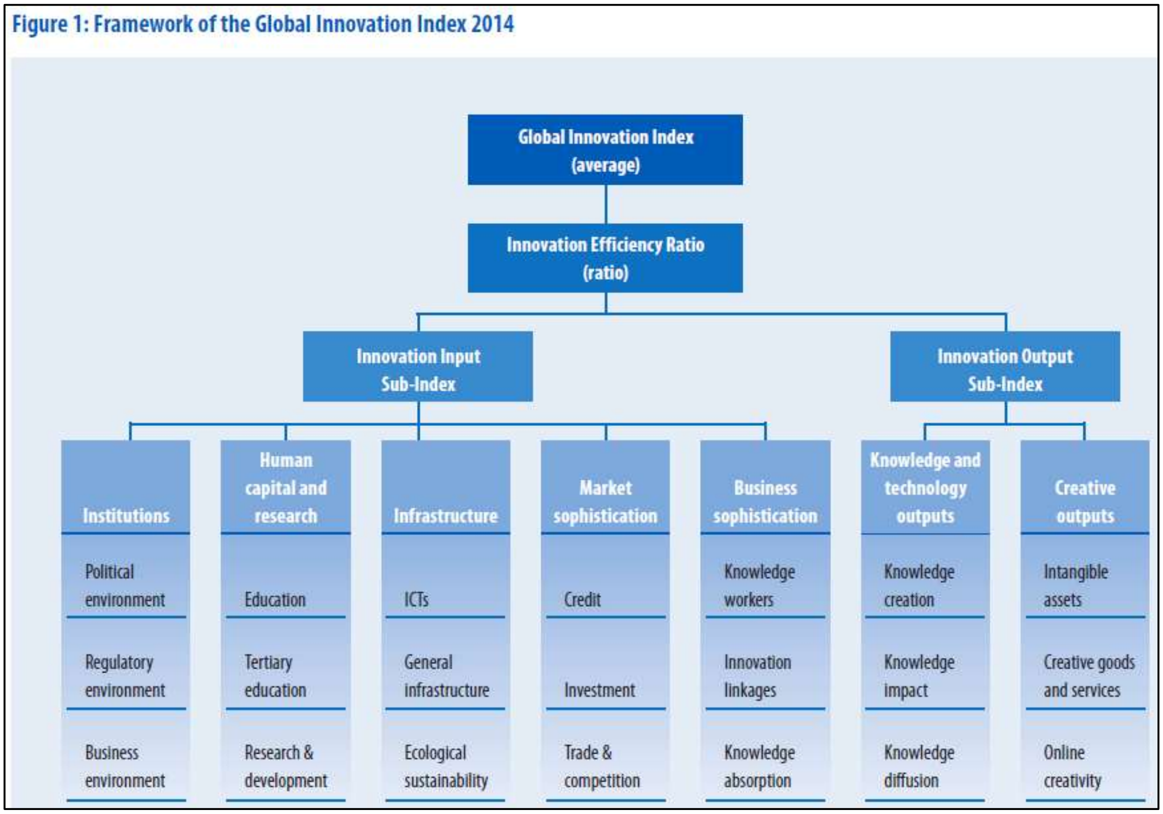


Fig. 9.1: Global Innovation Index 2014: Framework [131]

India

Key indicators

Population (millions)	1,236.7
GDP (US$ billions)	1,870.7
GDP per capita, PPP$	4,077.1
Income group	Lower-middle income
Region	Central and Southern Asia

	Score (0–100) or value (hard data)	Rank	
Global Innovation Index (out of 143)	**33.7**	**76**	
Innovation Output Sub-Index	30.4	65	
Innovation Input Sub-Index	37.0	93	
Innovation Efficiency Ratio	0.8	31	●
Global Innovation Index 2013 (out of 142)	36.2	66	

		Score/value	Rank	
1	**Institutions**	**50.8**	**106**	
1.1	Political environment	43.3	120	
1.1.1	Political stability*	35.2	126	○
1.1.2	Government effectiveness*	36.0	82	
1.1.3	Press freedom*	58.8	115	
1.2	Regulatory environment	62.2	83	
1.2.1	Regulatory quality*	36.5	108	
1.2.2	Rule of law*	43.5	64	
1.2.3	Cost of redundancy dismissal, salary weeks	15.8	73	
1.3	Business environment	47.0	128	○
1.3.1	Ease of starting a business*	62.7	129	○
1.3.2	Ease of resolving insolvency*	27.1	105	
1.3.3	Ease of paying taxes*	51.0	120	
2	**Human capital & research**	**22.7**	**96**	
2.1	Education	24.2	128	○
2.1.1	Expenditure on education, % GDP	3.2	109	
2.1.2	Gov't expenditure/pupil, secondary, % GDP/cap	12.6	90	
2.1.3	School life expectancy, years	11.7	91	
2.1.4	PISA scales in reading, maths, & science	336.0	62	○
2.1.5	Pupil-teacher ratio, secondary	25.9	92	
2.2	Tertiary education	11.7	122	○
2.2.1	Tertiary enrolment, % gross	23.3	86	
2.2.2	Graduates in science & engineering, %	n/a	n/a	
2.2.3	Tertiary inbound mobility, %	0.1	106	○
2.3	Research & development (R&D)	32.0	31	●
2.3.1	Researchers, headcounts/mn pop	n/a	n/a	
2.3.2	Gross expenditure on R&D, % GDP	0.8	41	
2.3.3	QS university ranking, average score top 3*	45.7	27	●
3	**Infrastructure**	**32.1**	**87**	
3.1	Information & communication technologies (ICTs)	25.9	99	
3.1.1	ICT access*	25.0	111	
3.1.2	ICT use*	6.5	112	
3.1.3	Government's online service*	53.6	56	
3.1.4	E-participation*	18.4	73	
3.2	General infrastructure	43.1	33	●
3.2.1	Electricity output, kWh/cap	847.6	95	
3.2.2	Logistics performance*	58.3	46	
3.2.3	Gross capital formation, % GDP	35.0	14	●
3.3	Ecological sustainability	27.4	106	
3.3.1	GDP/unit of energy use, 2005 PPP$/kg oil eq	5.3	80	
3.3.2	Environmental performance*	31.2	128	○
3.3.3	ISO 14001 environmental certificates/bn PPP$ GDP	n/a	n/a	
4	**Market sophistication**	**51.2**	**50**	
4.1	Credit	33.3	80	
4.1.1	Ease of getting credit*	81.3	27	
4.1.2	Domestic credit to private sector, % GDP	51.5	65	
4.1.3	Microfinance gross loans, % GDP	0.2	55	
4.2	Investment	44.2	41	
4.2.1	Ease of protecting investors*	63.3	32	
4.2.2	Market capitalization, % GDP	68.6	27	●
4.2.3	Total value of stocks traded, % GDP	33.8	26	●
4.2.4	Venture capital deals/tr PPP$ GDP	0.1	24	
4.3	Trade & competition	76.1	59	
4.3.1	Applied tariff rate, weighted mean, %	8.2	113	
4.3.2	Non-agricultural mkt access weighted tariff, %	1.8	89	
4.3.3	Intensity of local competition†	75.8	22	●
5	**Business sophistication**	**28.0**	**93**	
5.1	Knowledge workers	25.0	110	
5.1.1	Knowledge-intensive employment, %	n/a	n/a	
5.1.2	Firms offering formal training, % firms	15.9	97	○
5.1.3	GERD performed by business, % GDP	0.3	43	
5.1.4	GERD financed by business, %	35.5	50	
5.1.5	GMAT test takers/mn pop. 20–34	78.7	57	
5.2	Innovation linkages	38.9	46	
5.2.1	University/industry research collaboration†	50.0	43	
5.2.2	State of cluster development†	64.7	15	●
5.2.3	GERD financed by abroad, %	n/a	n/a	
5.2.4	JV–strategic alliance deals/tr PPP$ GDP	0.0	54	
5.2.5	Patent families filed in 3+ offices/bn PPP$ GDP	0.0	84	
5.3	Knowledge absorption	20.2	100	
5.3.1	Royalty & license fees payments, % total trade	0.8	35	
5.3.2	High-tech imports less re-imports, %	6.7	73	
5.3.3	Comm., computer & info. services imp., % total trade	0.7	75	
5.3.4	FDI net inflows, % GDP	1.7	89	
6	**Knowledge & technology outputs**	**32.2**	**50**	
6.1	Knowledge creation	18.4	57	
6.1.1	Domestic resident patent app./tr PPP$ GDP	2.0	52	
6.1.2	PCT resident patent app./tr PPP$ GDP	0.3	59	
6.1.3	Domestic res utility model app./tr PPP$ GDP	n/a	n/a	
6.1.4	Scientific & technical articles/bn PPP$ GDP	9.8	74	
6.1.5	Citable documents H index	301.0	24	●
6.2	Knowledge impact	34.1	87	
6.2.1	Growth rate of PPP$ GDP/worker, %	3.7	24	●
6.2.2	New businesses/th pop. 15–64	0.1	87	
6.2.3	Computer software spending, % GDP	0.1	74	○
6.2.4	ISO 9001 quality certificates/bn PPP$ GDP	6.2	59	
6.2.5	High- & medium-high-tech manufactures, %	31.8	33	
6.3	Knowledge diffusion	44.1	24	●
6.3.1	Royalty & license fees receipts, % total trade	0.1	61	
6.3.2	High-tech exports less re-exports, %	2.8	45	
6.3.3	Comm., computer & info. services exp., % total trade	9.8	1	●
6.3.4	FDI net outflows, % GDP	0.5	64	
7	**Creative outputs**	**28.6**	**82**	
7.1	Intangible assets	39.4	94	
7.1.1	Domestic res trademark app./bn PPP$ GDP	37.3	69	
7.1.2	Madrid trademark app. holders/bn PPP$ GDP	0.0	72	○
7.1.3	ICTs & business model creation†	63.5	39	
7.1.4	ICTs & organizational model creation†	60.0	38	
7.2	Creative goods & services	21.1	58	
7.2.1	Cultural & creative services exports, % total trade	0.1	65	
7.2.2	National feature films/mn pop. 15–69	1.5	58	
7.2.3	Global ent. & media output/th pop. 15–69	0.0	58	○
7.2.4	Printing & publishing manufactures, %	0.0	82	○
7.2.5	Creative goods exports, % total trade	4.3	13	●
7.3	Online creativity	14.7	78	
7.3.1	Generic top-level domains (TLDs)/th pop. 15–69	1.2	102	
7.3.2	Country-code TLDs/th pop. 15–69	14.9	88	
7.3.3	Wikipedia edits/pop. 15–69	536.9	106	
7.3.4	Video uploads on YouTube/pop. 15–69	41.6	58	○

Fig. 9.2: Global Innovation Index 2014: India

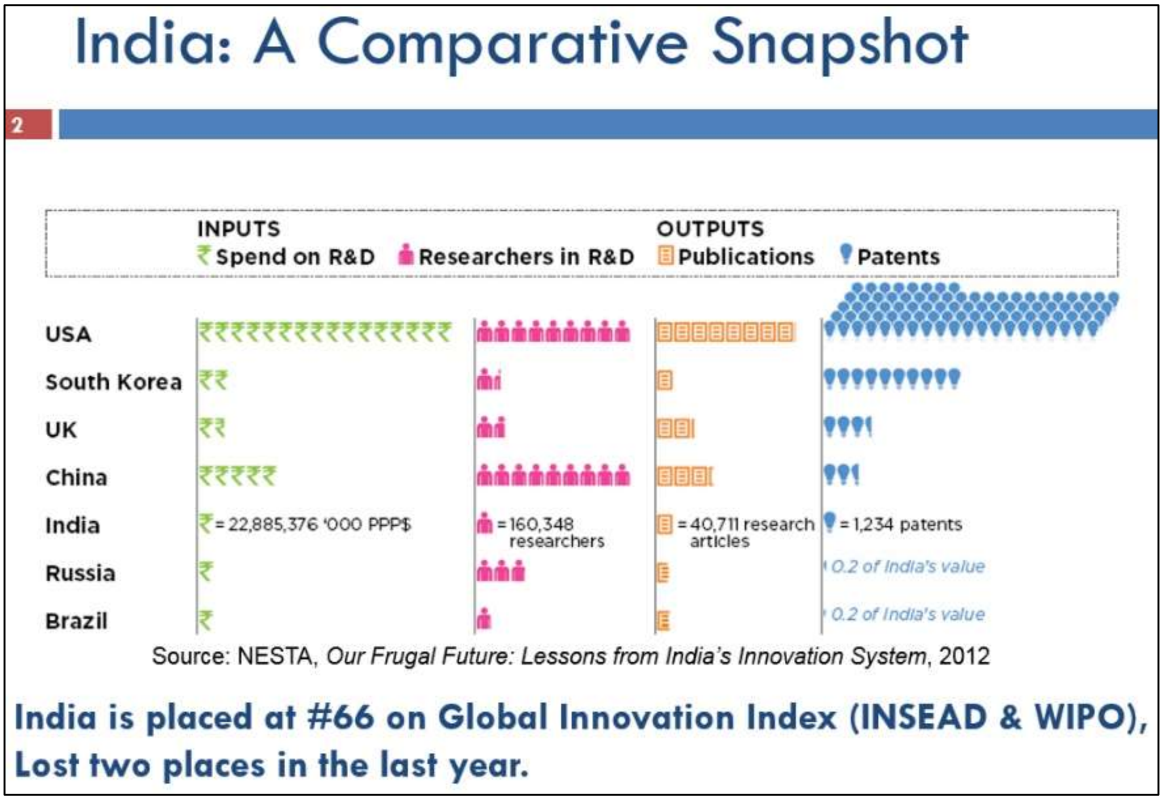


Fig. 9.3: Innovation: India Comparative Snapshot [49] [76]

In above figure, compare the data of South Korea and India. The South Korea's input is just double of India but number of Patents are 10 times higher than India. Similarly compare the data of UK and India. The UK's input is just double of India but number of Patents are 3.5 times higher than India.

GII Index make a distinction between innovation event and innovative structure by analyzing **innovation inputs** and **innovation outputs** separately. The data for Index is collected 143 countries and they rank according to their innovation indexes… Innovation ecosystem is mentioned under business sophistication along with the other pillars, intramural innovative environment and openness to international competition. According the GII, determinants of an innovation ecosystem are development of clustering, university-industry collaboration and culture to innovate. [254]

9.2. KPMG Global Technology Innovation Survey: US, China, India

As per the KPMG Global Technology Innovation Survey 2013, the Technology executives worldwide believe that the **US, China and India** are the top three countries with the potential to drive technology breakthroughs that will have a global impact in the next four years. The following figure shows the details as per KPMG Report 2012. [44]

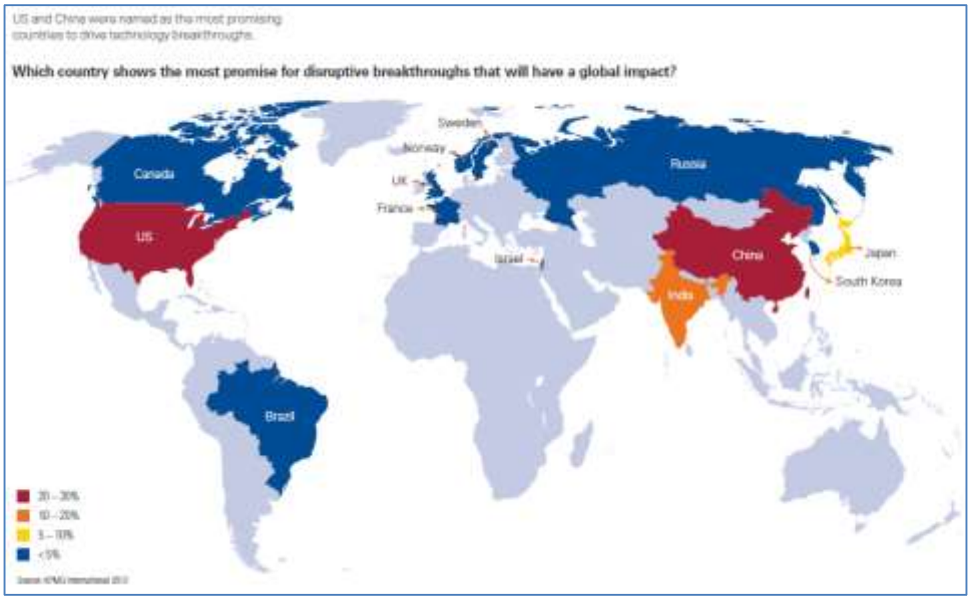


Fig. 9.4: KPMG Report 2012: The US and China were named as the most promising countries to drive technology breakthroughs [43]

9.3. Bloomberg Innovation Ranking 2014 Placed South Korea as a World Leader

Bloomberg Rankings recently examined 215 countries and sovereign regions to determine their innovation quotient. The final universe was narrowed to 110. What follows is the top 30. Innovation was measured by seven factors, including R&D intensity, productivity, high-tech density, researcher concentration, manufacturing capability, tertiary efficiency and patent activity. [70]

As per this report South Korea is the most Innovative country and Sweden is at second place.

BLOOMBERG RANKINGS www.bloomberg.com/rank

MOST INNOVATIVE IN THE WORLD 2014: COUNTRIES

South Korea and Sweden lead the world in innovation

Rank	Country	Total score	R&D intensity rank	Manufacturing capability rank	Productivity rank	High-tech density rank	Tertiary efficiency rank	Researcher concentration rank	Patent activity rank
1	South Korea	92.10	3	2	33	3	3	6	2
2	Sweden	90.80	4	22	7	5	13	8	26
3	United States	90.69	10	24	10	1	37	12	5
4	Japan	90.41	5	6	14	8	30	9	3
5	Germany	88.23	9	3	20	6	25	17	6
6	Denmark	86.97	6	56	6	17	27	3	14
7	Singapore	86.07	17	14	15	14	24	4	34
8	Switzerland	86.02	8	16	3	9	35	22	29
9	Finland	85.86	2	21	12	32	5	2	15
10	Taiwan	83.52	7	N/A	30	2	2	5	1
11	Canada	83.21	24	32	11	16	1	13	23
12	France	82.42	16	38	16	15	15	20	10
13	Australia	80.79	14	58	5	25	23	15	41
14	Norway	80.39	25	65	2	26	40	7	20
15	Netherlands	80.32	19	30	18	11	53	24	25

Table. 9.3: Bloomberg Innovation Ranking 2014 [70]

9.4. GIPC IP Index: India Ranked Last

The U.S. Chamber of Commerce **Global Intellectual Property Centre** recently released the latest 'International IP Index'. As per this report, India has been placed last in terms of protection and enforcement of Intellectual Property practices out of 25 countries. India scored only 6.95 points out of 30. US ranked the highest, scoring 28.5 on 30. [71]

It appears that India's key areas of weakness as per the index are:
1. Patentability requirements in violation of TRIPS
2. Regulatory data protection not available
3. Patent term restoration not available
4. Use of compulsory licensing for commercial and non-emergency situations
5. Limited takedown mechanism in ISP notification system
6. Limited DRM legislation
7. High levels of software piracy, music piracy, and counterfeit goods
8. Poor application and enforcement of civil remedies and criminal penalties
9. Not a contracting party to any of the major international IP treaties referenced in the IP Index [71]

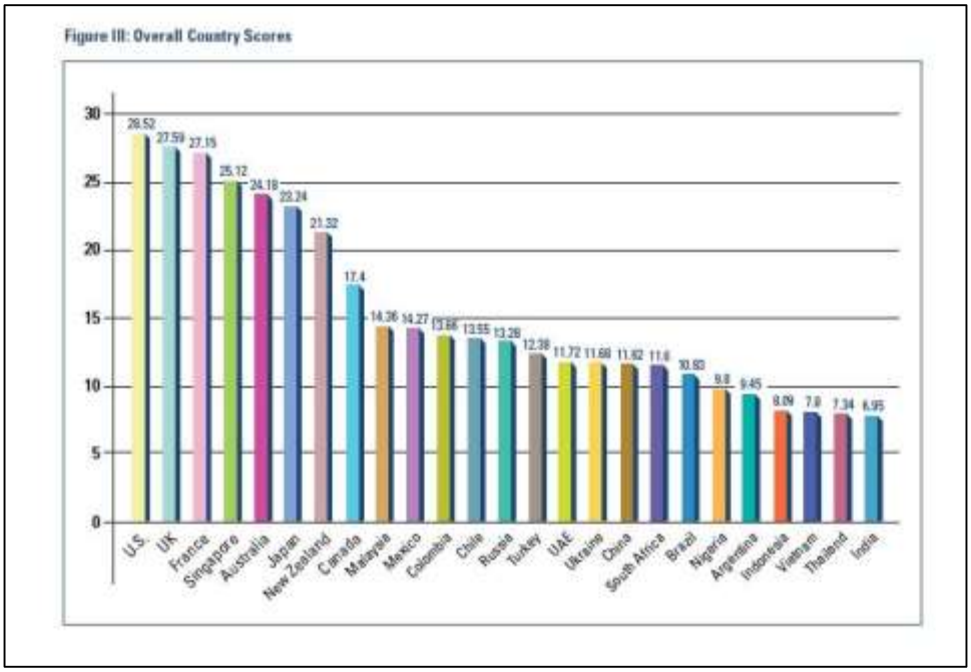


Fig. 9.5: GIPC IP Index: India Ranked Last [71]

9.5. GE Global Innovation Barometer 2014: India at 6th Position

India has been ranked the sixth most "innovative" country in the world in multinational conglomerate GE's Annual Global Innovation Barometer, driven by financial support from public authorities and long-term support from investors. The report, based on a survey of 2,800 senior business executives in 22 countries, including 200 respondents in India, identifies the top enablers for innovation in the country as talent ('creative' talent and people with technical expertise), financial support from public authorities and long-term support from investors. When asked to identify the three countries they consider "innovation champions", 65 per cent of the global respondents identified the US, followed by Germany (48 per cent), Japan (45 per cent), China (38 per cent), Korea (13 per cent) and India (12 per cent). [144]

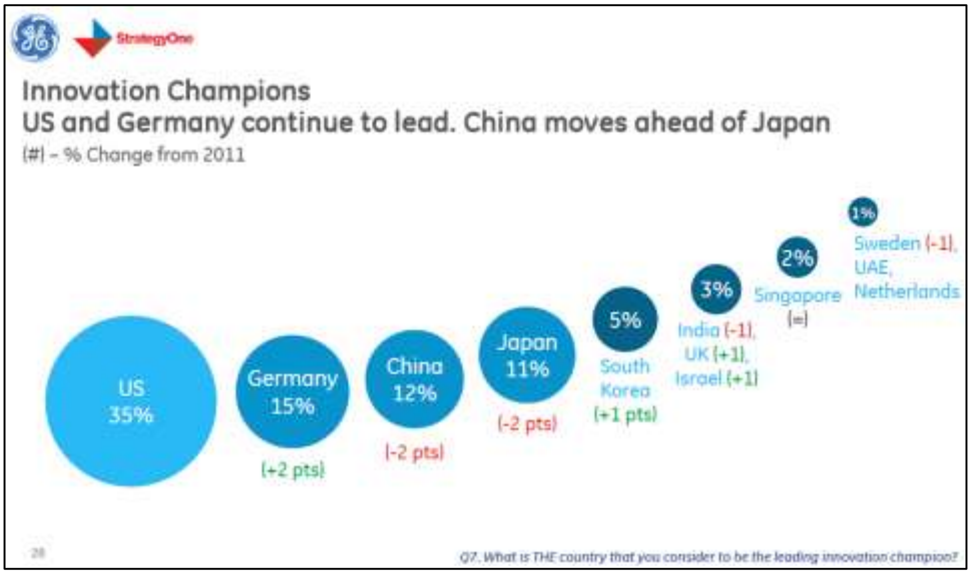


Fig. 9.6: GE Global Innovation Barometer 2014 [145]

Fig. 9.7: GE Global Innovation Barometer: Main Priorities Country Should Focus On To Efficiently Support Innovation [393]

9.6. The Global Competitiveness Index 2014

The 565 pages report of the Global Competitiveness Index 2014 is an excellent document, which highlighted many issues related to development of developing countries, especially applicable to India. [158]

Innovation Top 10

The Global Competitiveness Index 2014-2015	Global rank*
Finland	1
Switzerland	2
Israel	3
Japan	4
United States	5
Germany	6
Sweden	7
Netherlands	8
Singapore	9
Taiwan, China	10

Source: The Global Competitiveness Report 2014-2015
Note: * 2014-2015 rank out of 144 economies

Fig. 9.8: The Global Competitiveness Index 2014: Innovation Top 10 [157]

The position of India in the global competitiveness index 2014 is **71**. Continuing on its downward trend and losing 11 places, India ranks 71st. Overall, India does best in the more complex areas of the **GCI: innovation (49th)** and business sophistication (57th). It ranks a low **93rd in the higher education and training** pillar of the GCI. India achieves its lowest rank among the 12 pillars in **technological readiness (121st).** Only 15 percent of Indians access the Internet on a regular basis. At 28th, China stands some 40 places ahead of India, the other regional economic giant. [158]

India's overall GCI rank

Year	Rank
2007–2008	48th/131
2008–2009	50th/134
2009–2010	49th/133
2010–2011	51st/139
2011–2012	56th/142
2012–2013	59th/144
2013–2014	60th/148
2014–2015	**71st/144**

Table 9.4: India's overall Global Competeviness rank is not improving [158]

Improving competitiveness will yield India huge benefits. In particular, it will help rebalance the economy and move the country up the value chain so as to ensure more solid and stable growth; this in turn could result in **more employment opportunities** for the country's rapidly growing population. Despite the abundance of low-cost labor, **India has a very narrow manufacturing base. Manufacturing accounts for less than 15 percent of India's GDP**. [158]

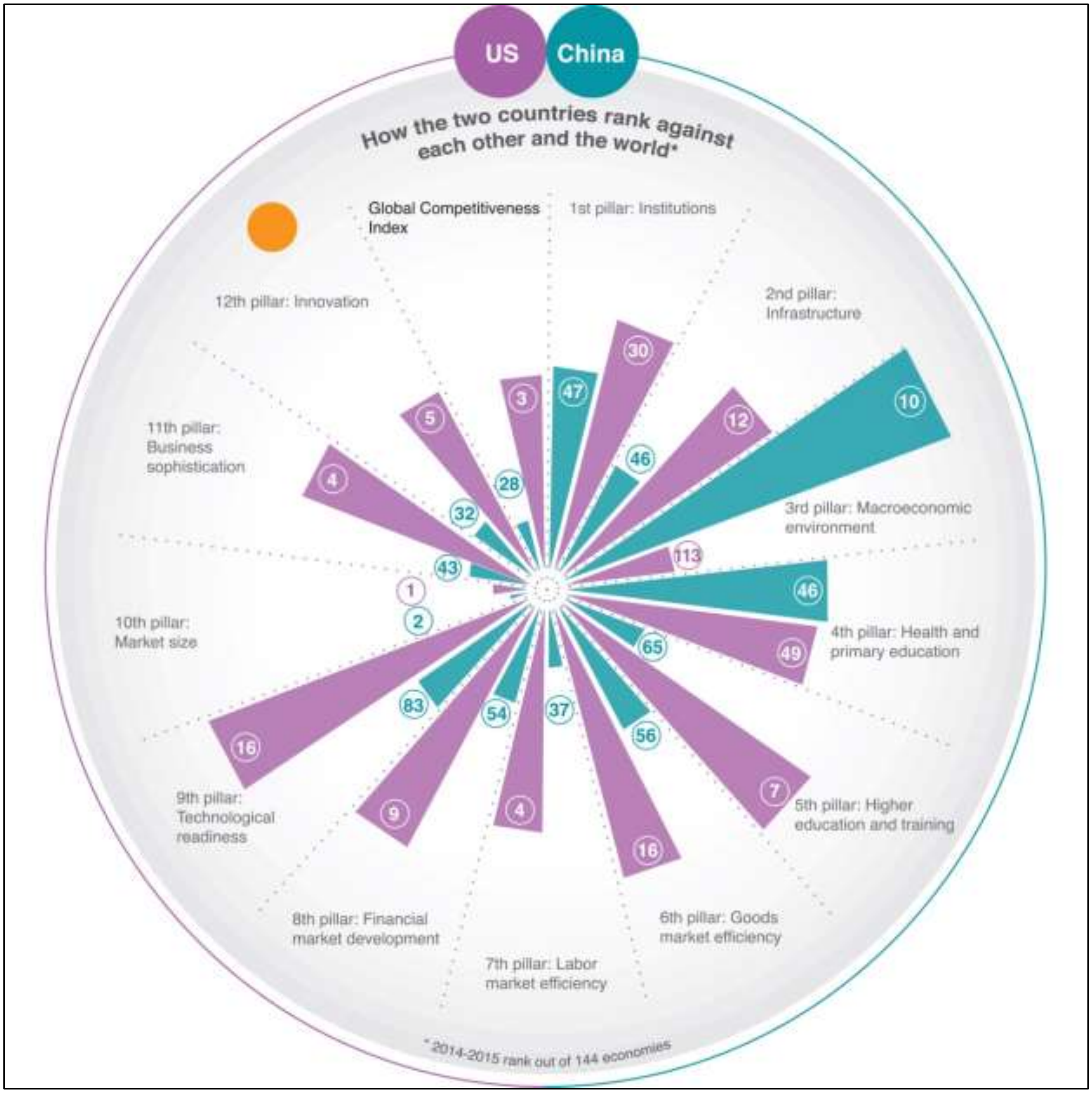


Fig. 9.9: Innovation is one of the most important pillar of global competitiveness [157]

The final pillar of competitiveness focuses on **technological innovation**. Although substantial gains can be obtained by improving institutions, building infrastructure, reducing macroeconomic instability, or improving human capital, all these factors eventually run into diminishing returns. The same is true for the efficiency of the labor, financial, and goods markets. In the long run, standards of living can be largely enhanced by technological innovation. Technological breakthroughs have been at the basis of many of the productivity gains that our economies have historically experienced. These range from the industrial revolution in the 18th century and the invention of **the steam engine** and the **generation of electricity** to the more recent **digital revolution**. The latter is not only transforming the way things are being done, but also opening a wider range of new possibilities in terms of products and services. **Innovation is particularly important for economies** as they approach the frontiers of knowledge, and the possibility of generating more value by merely integrating and adapting exogenous technologies tends to disappear. [158]

Although less-advanced countries can still improve their productivity by adopting existing technologies or making incremental improvements in other areas, for those that have reached the **innovation stage** of development this is no longer sufficient for increasing productivity. Firms in these countries must design and develop cutting-edge products and processes to maintain a competitive edge and move toward even higher value-added activities. This progression requires an environment that is conducive to **innovative activity** and supported by both the public and the private sectors. In particular, it means **sufficient investment in research and development (R&D), especially by the private sector**; the presence of high-quality scientific research institutions that can generate the basic knowledge **needed to build the new technologies; extensive collaboration in research and technological developments between universities and industry**; and the protection of intellectual property, in addition to high levels of competition and access to venture capital and financing that are analyzed in other pillars of the Index. In light of the recent sluggish recovery and rising fiscal pressures faced by advanced economies, it is important that public and private sectors resist pressures to cut back on the R&D spending that will be so critical for sustainable growth into the future. [158]

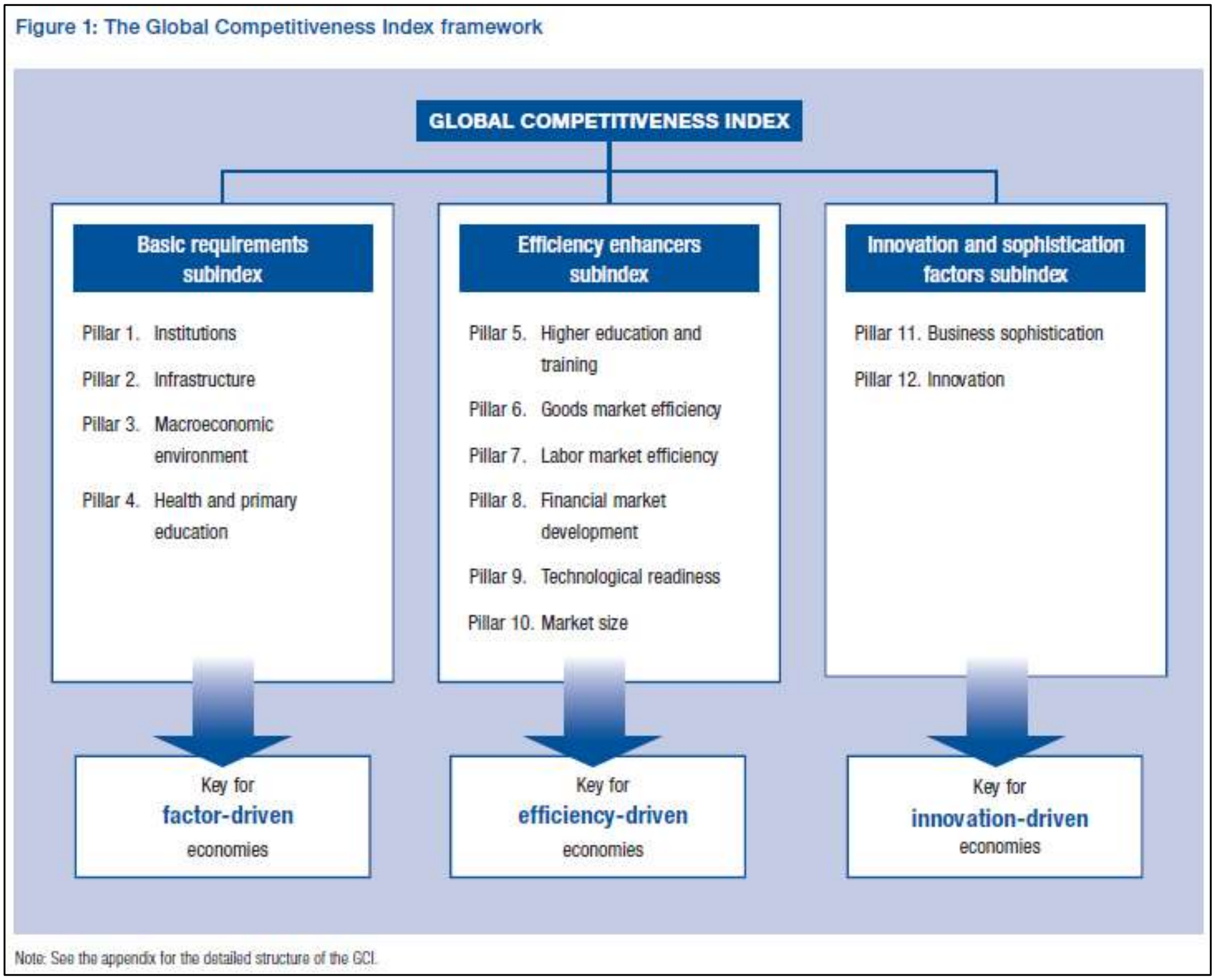


Fig. 9.10: The Global Competitiveness Index 2014: Framework [158]

Table 1: Subindex weights and income thresholds for stages of development

	STAGE OF DEVELOPMENT				
	Stage 1: Factor-driven	Transition from stage 1 to stage 2	Stage 2: Efficiency-driven	Transition from stage 2 to stage 3	Stage 3: Innovation-driven
GDP per capita (US$) thresholds*	<2,000	2,000–2,999	3,000–8,999	9,000–17,000	>17,000
Weight for basic requirements	60%	40–60%	40%	20–40%	20%
Weight for efficiency enhancers	35%	35–50%	50%	50%	50%
Weight for innovation and sophistication factors	5%	5–10%	10%	10–30%	30%

Note: See individual country/economy profiles for the exact applied weights.
* For economies with a high dependency on mineral resources, GDP per capita is not the sole criterion for the determination of the stage of development. See text for details.

Table. 9.5: **Stages of Development Related to GDP per capita**: Stage 3 in Innovation Driven (see last column of the table) [158]

Table 2: Countries/economies at each stage of development

Stage 1: Factor-driven (37 economies)	Transition from stage 1 to stage 2 (16 economies)	Stage 2: Efficiency-driven (30 economies)	Transition from stage 2 to stage 3 (24 economies)	Stage 3: Innovation-driven (37 economies)
Bangladesh	Algeria	Albania	Argentina	Australia
Burkina Faso	Angola	Armenia	Bahrain	Austria
Burundi	Azerbaijan	Bulgaria	Barbados	Belgium
Cambodia	Bhutan	Cape Verde	Brazil	Canada
Cameroon	Bolivia	China	Chile	Cyprus
Chad	Botswana	Colombia	Costa Rica	Czech Republic
Côte d'Ivoire	Gabon	Dominican Republic	Croatia	Denmark
Ethiopia	Honduras	Egypt	Hungary	Estonia
Gambia, The	Iran, Islamic Rep.	El Salvador	Kazakhstan	Finland
Ghana	Kuwait	Georgia	Latvia	France
Guinea	Libya	Guatemala	Lebanon	Germany
Haiti	Moldova	Guyana	Lithuania	Greece
India	Mongolia	Indonesia	Malaysia	Hong Kong SAR
Kenya	Philippines	Jamaica	Mauritius	Iceland
Kyrgyz Republic	Saudi Arabia	Jordan	Mexico	Ireland
Lao PDR	Venezuela	Macedonia, FYR	Oman	Israel
Lesotho		Montenegro	Panama	Italy
Madagascar		Morocco	Poland	Japan
Malawi		Namibia	Russian Federation	Korea, Rep.
Mali		Paraguay	Seychelles	Luxembourg
Mauritania		Peru	Suriname	Malta
Mozambique		Romania	Turkey	Netherlands
Myanmar		Serbia	United Arab Emirates	New Zealand
Nepal		South Africa	Uruguay	Norway
Nicaragua		Sri Lanka		Portugal
Nigeria		Swaziland		Puerto Rico
Pakistan		Thailand		Qatar
Rwanda		Timor-Leste		Singapore
Senegal		Tunisia		Slovak Republic
Sierra Leone		Ukraine		Slovenia
Tajikistan				Spain
Tanzania				Sweden
Uganda				Switzerland
Vietnam				Taiwan, China
Yemen				Trinidad and Tobago
Zambia				United Kingdom
Zimbabwe				United States

Table 9.6: Countries/economies at each stage of development [158]

Stages of Economic Development In the factor-driven stage countries compete based on their factor endowments, primarily unskilled labor and natural resources. Companies compete on the basis of prices and sell basic products or commodities, with their low productivity reflected in low wages. To maintain competitiveness at this stage of development, competitiveness hinges mainly on a stable macroeconomic framework (pillar 1), well-functioning public and private institutions (pillar 2), appropriate infrastructure (pillar 3), and a healthy, literate workforce (pillar 4). [164]

As wages rise with advancing development, countries move into the efficiency-driven stage (Old model 3 pillars but in new model bifurcated to 6 pillars) of development, when they must begin to develop more efficient production processes and increase product quality. At this point, competitiveness becomes increasingly driven by higher education and training (pillar 5), efficient markets (pillar 6), and the ability to harness the benefits of existing technologies (pillar 7) (from pillar 5 to 10). [164]

Finally, as countries move into the innovation-driven stage, they are only able to sustain higher wages and the associated standard of living if their businesses are able to compete with new and unique products. At this stage, companies must compete through innovation (pillar 12), producing new and different goods using the most sophisticated production processes (pillar 11). Thus, although all nine pillars matter to a certain extent for all countries, the importance of each one depends on a country's particular stage of development. To take this into account, the pillars are organized into three sub-indexes, each critical to a particular stage of development. [164]

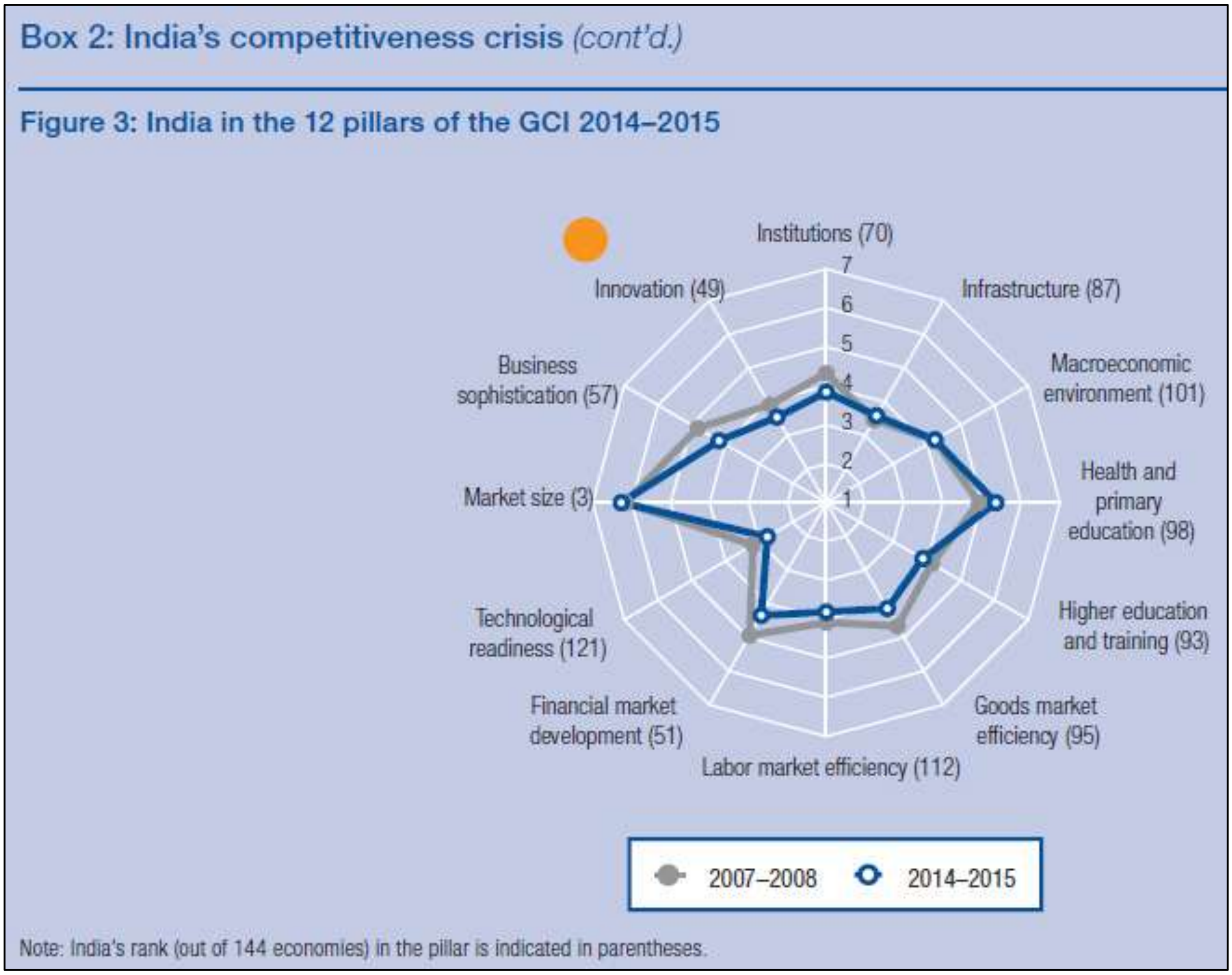


Fig. 9.11: India: Competitiveness Crisis [158]

I have just included few points. Reader must read this 565 pages report for detailed information.

9.7. Rating Universities on Innovation: QS Stars and Times HE

Innovation is one of the criteria assessed by the QS Stars university rating service for universities. But how can this be measured? While a lot of research done at universities involves things that necessarily remain within the academic realm, there is no shortage of work carried out for non-academic purposes. Universities have historically played a crucial role in driving industry through innovation, and particularly in areas such science and technology links with the non-academic world remain central to their mission. This measure rewards universities whose work goes beyond the confines of academia. Scores from three criteria go towards a university's score in innovation and knowledge transfer: [64]

Patents (20 points)

One significant way a university's work can have an impact outside of the academic community is through coming up with innovations with instant practical applications, which can range from niche scientific and industrial fields to day-to-day life. A good way to measure this is the number of patents that are registered with national and international patent offices. Fifty or more and we will award full points. [64]

Spin-off companies (10 points)

Much of the work done in universities is easily marketable, and therefore it is common for independent spin-off companies to be founded in order to take advantage of these unique assets. This indicates that universities are carrying out work that is demand in the world beyond their own walls, and that researchers are able to profit by the important and innovative work that they are doing – and, perhaps most importantly, that the university is willing to support them. If five such companies have been established in the past five years and are now operating without support from the university, then maximum points are awarded. [64]

Industrial research (20 points)

Universities and independent corporations have a mutually beneficial relationship. The former can provide their unique expertise, the latter the capital necessary to engage on large research projects – both can provide facilities to which the other wouldn't normally have access. Once again, this is an example of work being done in a university with a direct impact on the real world. This can be work that simply meets the needs of a company, or could be work that represents far reaching and significant progress in a particular field. For full points here a university must have engaged in joint research projects with ten distinct corporations, which have led to publications in abstract and citation database Scopus over the last five years. [64]

Fig. 9.12: QS Star Ranking Criterion for Innovation [65]

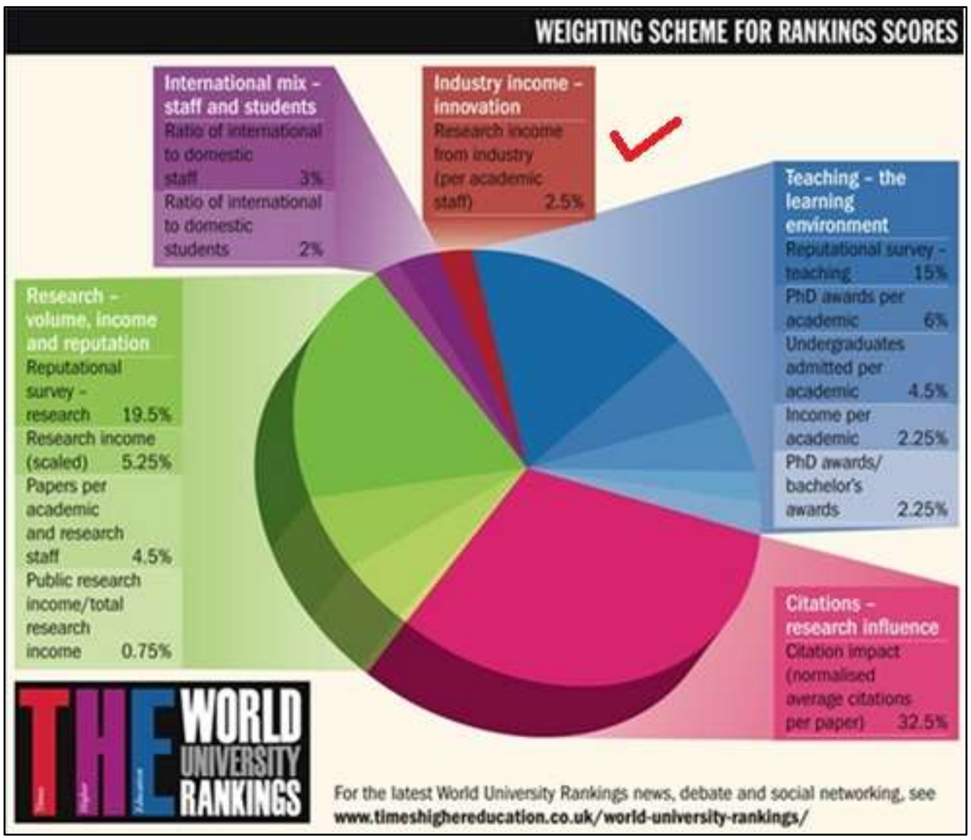


Fig. 9.13: Times HE Ranking Weightage for Innovation [66] [67]

9.8. Report on Innovation Ecosystem by MIT USA & Skoltech Russia

The US and the UK remain at the top of the list of countries with the greatest number of universities contributing to the creation of the most successful entrepreneurial ecosystems worldwide. This is the assessment made by the **Technology Innovation Ecosystem Benchmarking Study** conducted by the Massachusetts Institute of Technology (MIT) in collaboration with the Skolkovo Institute of Science and Technology (Skoltech), a private graduate research university based in Skolkovo, a suburb of Moscow, Russia, which was founded in 2011 in collaboration with MIT. This report is the first part of a three-phase study focusing on the question of which institutes of higher learning have the best "**university-based technology innovation ecosystems**". While **US and UK universities remain at the top of the list**, new arrivals in the rankings, notably Israeli university Technion, seem to portend changes in this competitive environment. [68]

9.9. Creative Productivity Index (CPI) by Asian Development Bank and Economist Intelligence Unit

India ranked **14th on a list of 22 Asia-Pacific economies** on Creative Productivity Index, being launched on Friday by the Asian Development Bank and Economist Intelligence Unit. The report carrying the ADB-EIU index said regulatory hurdles, red tape and corruption provide little incentive for the private sector to invest in innovation in India. The index is designed to give policymakers a tool to measure progress in fostering creativity and innovation in 22 Asia-Pacific economies (plus those of the US and Finland, for comparison purposes). It measures the innovative and creative capacity of economies by relating creative inputs to outputs. On the input side, creative productivity is measured on three dimensions - the capacity to innovate, incentives to innovate and how conducive the environment is for innovation. The output side measures innovations by considering both conventional indicators such as the number of patents filed, as well as a broader set of measures on knowledge creation. While India is ranked lower on the input side at 15, compared to its overall rank, it has a relatively better score at 13 on the output side. This implies **India is able to get a bit better of an output compared to its inputs**. [548]

MEASURING PROGRESS

Creative Productivity Index ranking

Japan	1
Finland	2
Republic of Korea	3
United States	4
Hong Kong, China	7
Singapore	10
China	11
India	**14**
Philippines	18
Pakistan	23

Sources: Asian Development Bank, The Economist Intelligence Unit

Fig. 9.14: Creative Productivity Index Ranking [548] [549]

Fostering innovation and creativity has an important and tangible impact on economic performance. A strong Creative Productivity Index CPI value means that a country is efficiently translating its investments into desirable outputs. [547]

A new Creative Productivity Index (CPI) developed by the Asian Development Bank (ADB) and Economist Intelligence Unit (EIU) ranks Japan and the Republic of Korea as the most efficient countries in the Asia-Pacific region at turning creative inputs into tangible innovation. Myanmar, Pakistan, and Cambodia, by contrast, are ranked as the least efficient innovators. The September 12 2014 report titled Creative Productivity Index: Analyzing Creativity and Innovation in Asia aims, among other things, to give policymakers a tool to assess how best to foster innovation and creativity in Asian economies. [547] [550]

The index uses **36 input indicators** to measure the capacity and incentives for innovation, including how many global top 500 universities a country has, the urbanization rate, spending on research and development, protection of intellectual property rights, and corruption and bureaucracy. The **eight output indicators** to measure innovation include the number of patents filed, export sophistication, value added to agriculture, and the number of books and films produced. [547] [549]

Shanti Jagannathan, Senior Education Specialist at ADB and co-author of the report, says in a DW interview that the **key factors driving innovation in countries such as Japan, South Korea and Singapore** are **high investments in research and development (R&D)** as a proportion of gross domestic product (GDP) and the linking of high education standards to the needs and priorities of economic growth strategies. [547] [550]

9.10. UKIERI & NESTA UK Report on Innovation & India: Colonialism 2.0

The UK India Education and Research Initiative (**UKIERI**) started in April 2006 with the aim of enhancing educational links between India and the UK. In the last five years, UKIERI has played a pivotal role in establishing a step change in the educational relations between the two countries. **NESTA** (National Endowment for Science, Technology and the Arts) is an independent charity that works to increase the innovation capacity of the UK. The organization acts through a combination of practical programmes, investment, policy and research, and the formation of partnerships to promote innovation across a broad range of sectors. [32] [33]

The **UKIERI** and **NESTA** has published a wonderful Report namely "**The Future of Indian Higher Education and its Impact on Research and Innovation**". This report highlights the key issues related to Innovation. In this project over 700 organizations (25 Institutes of National Importance, 37 Indian Research Institutions, 253 other Indian Universities or Colleges, 347 Corporations, 74 Multi-National Corporations) were involved. More than 80% of the participants were at the equivalent of Vice, Chancellor, Director or CEO level. I would like to include few important remarks from this report. [31]

- **Innovation is the key driver** of economic growth and improvements in the standard of living. Nations, organizations and individuals thrive on it. In turn innovation needs talent and a supportive culture. **India has an opportunity to drive global innovation in the 21st Century** but there are **serious questions** as to whether the higher education system will be able to **unlock this potential**. [31]

- From a wider perspective India needs to reallocate its resources (intellectual and financial) away **from outsourcing and into innovation**. **India's intellectual talent is currently geared towards innovation for others – directly through MNC's captive centres and indirectly through the outsourcing to India of MNC research and development.** This represents the **single greatest limitation on India's future growth**. Outsourcing has been characterized as "**Colonialism 2.0**" defined by an emphasis on the export of India's "raw materials rather than high value finished products". Domestic industries (both public and private) have massively underinvested in R&D. [31]
- Hi-Tech-Enabled outsourcing is a present day **equivalent to** the Low-Tech-Enabled British policy of **importing cotton from India only to export back manufactured textiles**. A similar process is at work with the US using Indian IT services to strengthen its domestic technology base. As ex-US diplomat William H. Avery says, "the effect is the same: a **colonial style enrichment of other nations**, at India's expense." The willingness of India to engage in this trade concerns Avery: "Indian industry, led by its outsourcers, is thinking too small….**India should aspire to be the global leader in technology products, not in technology services**." [31]
- Paradoxically sustained success in outsourcing would be a measure of India's failure to achieve its potential. Outsourcing runs counter to India's long---term objectives. The business model works because India remains relatively poor and the cost of skilled labor is lower than elsewhere. As incomes (or the relative value of the rupee) rise, outsourcing will become less competitive and move on. **Innovation is therefore essential for India to move up the value chain**. [31]

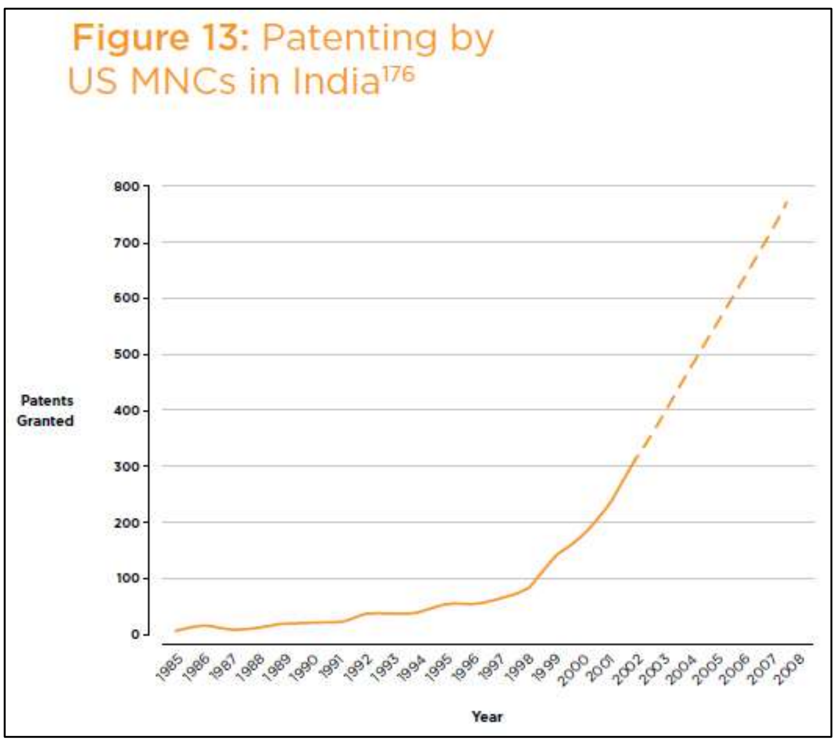


Fig. 9.15: Patents of US MNC in India [76]

Fig. 9.16: Innovation in India and China by Multi-National Companies [77]

- Over the next decade Indian corporate and political leadership is expected to begin exploiting the current outsourcing phase in order to **create an innovation ecosystem on a scale never before seen in India or possibly anywhere in history**. Countries and companies that have hollowed out their own innovation ecosystems through underinvestment and outsourcing could increasingly struggle to compete with a young and dynamic India. This best---case scenario for India would see an ecosystem develop with ability to **attract talent and capital from across the world**. [31]
- The India of 2022 will have two huge advantages over the rest of the world: the ability to leverage both an enormous domestic market and talent pool. The big question is whether India will be able to capitalize on this historic opportunity. To achieve this India **needs to promote home-grown innovation** and most importantly **develop a higher education system** to support it. [31]

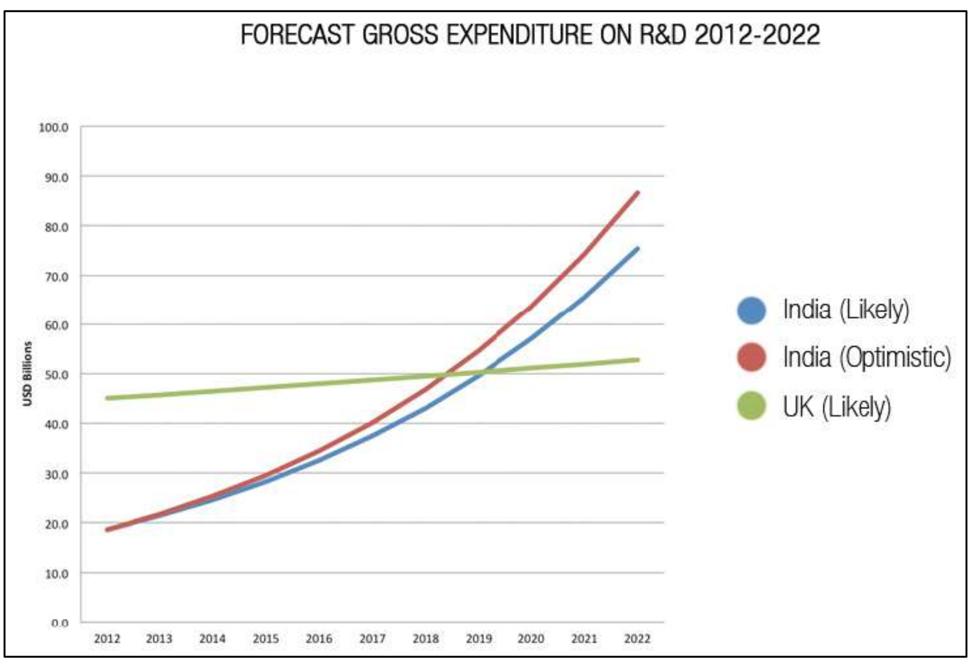


Fig. 9.17: R&D Expenditure of India and UK [31]

The **Key Finding** of this report are really mind blowing. I would like to quote few interesting key findings.

- What are the Government's policies and initiatives for higher education?
    - The regulatory landscape is likely to have shifted considerably by 2022
    - For---profit education may be allowed
- What does the higher education landscape look like?
    - There is widespread support from institutions and industry for the proposed higher education reforms
    - Our survey suggests that in the field of Computer Science – where Indian institutional research is currently surprisingly weak
- What are the emerging trends in Indian higher education?
    - Philanthropic support is increasing e.g. Azim Premji
    - Existing institutions have ambitious expansion plans including multi---campus models as well as optimizing existing infrastructure and land
- Who will do the teaching and what will be taught?
    - Attracting faculty from overseas
    - Attracting visiting faculty from industry
    - Improving the academic environment to attract graduates back from industry and towards academic careers
- What is the role of industry in Indian higher education?
    - Industry is keen to help by supporting curriculum design, providing visiting faculty and more work---experience opportunities
- How will Research and Development be funded?
    - India's annual investment in R&D will overtake the UK within 7 years
    - The private sector will rise to the challenge and invest heavily in R&D – our survey suggests a tripling in spend over the next 5 years
- What will happen to Indian research output?
    - India will overtake the UK in terms of output by number of publications by 2022
    - India's nascent research culture will encourage innovation
- **What is India's innovation agenda**?
    - Level of innovation happening is underestimated as it is often "invisible" due to it happening within the outsourcing paradigm or in MNC captive research centres
    - National Innovation Council to inspire more structure investment and the introduction of policies to strengthen industry---academia interactions

The readers should refer this 100 pages report on Innovation for more detailed information. [31]

Chapter 10: Analysis of Indian Innovation Ecosystem: Need of Effective & Organized System

*"**In India, the R&D expenditure is very low** in comparison to countries like US, China and Israel. Industry **needs to invest more on R&D and innovation to spur growth in the Manufacturing Sector**. Manufacturing growth in turn is **primarily the result of innovation** and we need to measure innovation capabilities and performance of countries around the world to evaluate progress and priorities." - Mr. Jayant Davar, Immediate Past Chairman, CII Northern Region [201]*

***India needs a national innovation ecosystem** that puts in place a financing cycle: academia generate ideas, especially those based on science and technology, which are incubated to proof of concept through government sponsored seed and incubation funding, and then taken to market through businesses backed by venture funding. **It seems that India lacks mechanisms helping the innovation to germinate and take root.** [204]*

*U.S tech companies have been the driving forces behind innovation in America for over two hundred years. **Together IBM and General Electric have filed over 1.5 million patents**, 60 times the number filed by the U.S. government…* **G.E. now files an average of more than five patents per day** — 20,000 patents over the last decade. *[686] [688]*

10.1. Definition & Elements of NIS

10.1.1. Definitions of NIS

The main idea behind an innovation system is synergy between the major innovation players to create better, cheaper products that meet consumer needs. [208]

The various definitions of National Innovation Ecosystem or System (NIS) are as follows:

National Innovation Systems: Definitions

- "*.. the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies.*" (Freeman, 1987)
- "*.. the elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge ... and are either located within or rooted inside the borders of a nation state.*" (Lundvall, 1992)
- "*... a set of institutions whose interactions determine the innovative performance ... of national firms.*" (Nelson, 1993)
- "*.. the national institutions, their incentive structures and their competencies, that determine the rate and direction of technological learning (or the volume and composition of change generating activities) in a country.*" (Patel and Pavitt, 1994)
- "*.. that set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which Governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies.*" (Metcalfe, 1995)

Box 1: Overview over definitions of national innovation systems [3]

Fig. 10.1: National Innovation Systems: Definitions [402]

10.1.2. Major Elements of NIS

Broadly, a national innovation system has the following major elements:

- Investment
    - R&D Expenditure and Government R&D Support

  - Venture Capital, and
  - FDI
- Infrastructure
  - Science & Technology institutions
  - Intellectual Property Rights
  - Government Policy
  - ICT and
  - Culture
- Knowledge and skills generation
  - Education and Human Resources development, and
  - Labor Flexibility
- Relations and Linkages
  - University-Industry Linkages
  - Public R&D and Industry
  - Globalization of MNC R&D
  - Transnational Networks [237]

To have an effective National Innovation System, every player in this gamut, viz. **government** (both Central and State), **R&D institutions** (both publicly funded & Private), **academia** (IITs, IIMs, Universities, NITs and even private Engineering Colleges), **industries** (both public & private sectors), **financial institutions** (venture capitalists, Angle funding etc.), **individual innovators** has to **play a very focused and distinctive role**. There must be a very **strong networking amongst above-mentioned agencies**. It is suggested that **monitoring can be done by National Innovation Council**… There is no second thought that **India needs a very effective National Innovation System**. Some efforts are being pursued by Government agencies and corporate houses, in this clirestron however, **more concerted efforts are needed**. [398]

Figure 1: **Various players of National Innovation System**

3. INNOVATION ECO-SYSTEM

- Innovation is the result of a complex interplay of dynamics among various players such as
  - Government
  - Firms
  - Schools/ Education and Research Institutions
  - Finance
  - Individual Innovators
  - Customers/users
  - NGOs / Civil Society/ Grassroots organisations
  - Media
- Policies and activities in these domains, as well as the interaction among these players influence the innovation eco-system
- NInC can act as a catalyst for stimulating the innovation eco-system by
  - Empowering people to innovate
  - Providing Policy Direction
  - Identifying knowledge/ innovation flows and gaps
  - Providing a collaborative platform for existing innovators
  - Applying innovation to address social and development challenges
  - Stimulating innovation at National/ State and Sectoral levels

Fig. 10.2: Innovation Ecosystem: Components [214] [215] [218] [398]

10.1.3. Objectives of Different Elements of NIS

Figure 20: Broad R&D objectives of different entities

MNCs	Academia	Corporate R&D	NGOs	National Labs	Start - ups
• R&D directed towards global business • Products customized for different regions based on economic, social, political and environmental needs	• Focus on fundamental research and capability development for staff and students • Emphasis on publications • Limited industrial research	• Product oriented research • More market focus • Aims at attaining high return on investment in products with respect to sales and profits	• Work focused on societal needs • Not normally profit oriented • Preference given to work related to rural development, optimized utilization of resources etc.	• Preference given to development of indigenous technologies beneficial for the nation. • Research projects selected by staff • Generate trained scientists for the country	• Focus on one particular field • Address smaller sized markets • Limited funds for in-depth research

Fig. 10.3: Broad R&D objectives of different entities [149]

10.1.4. Complex Functioning of NIS

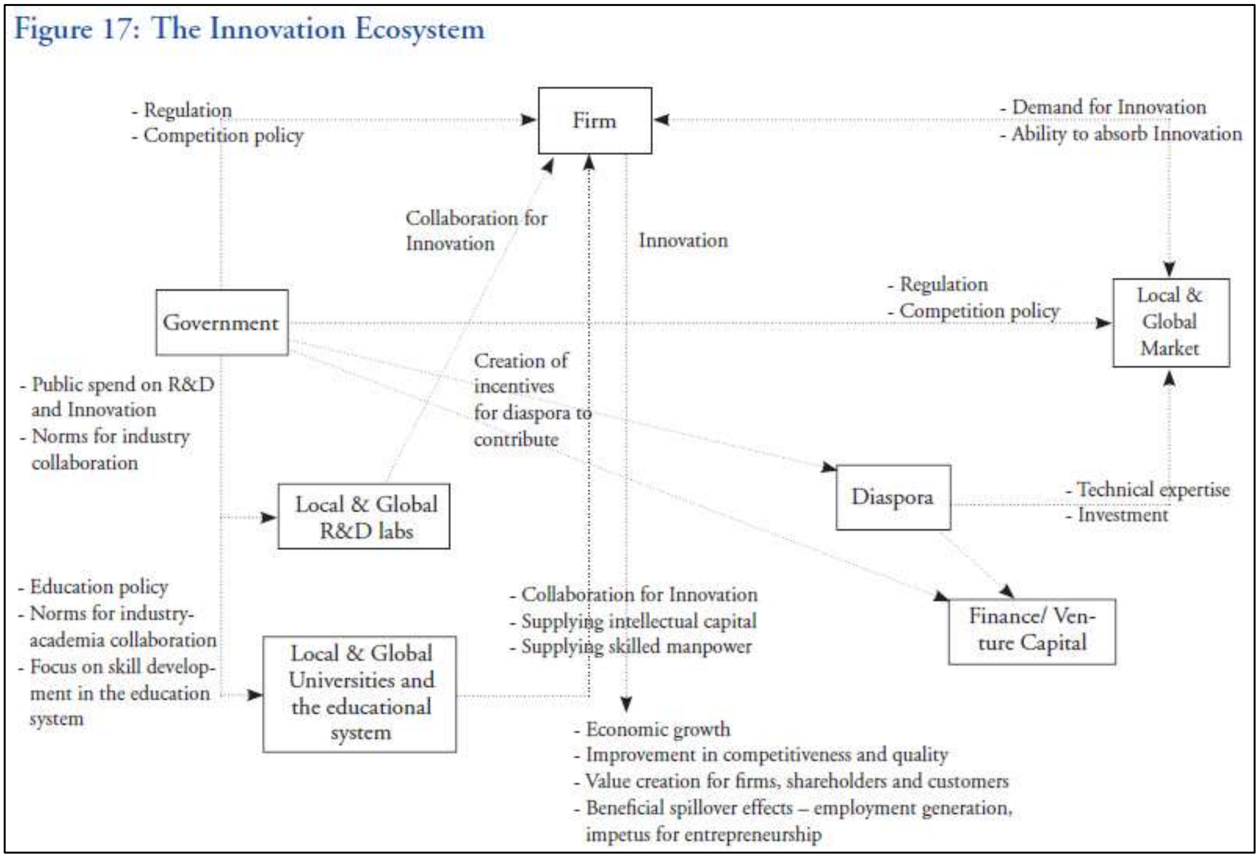


Fig. 10.4: Innovation Ecosystem: Components [218]

The Innovation Ecosystem, as seen above Figure, is a complex environment that requires the coordinated functioning of a number of diverse factors in order to function effectively. [218]

10.2. India Innovation Ecosystem: Different Views

Prof. Bhushan Patwardhan, Former Vice Chancellor of Symbiosis International University Pune, in his article in "Financial Express" stated that "India is currently at the crossroads of immense opportunity that necessitates urgent action. It needs to speak the language of innovation to address the existing 'innovation gap' and help build the bridges that are needed between researchers and implementers. The foremost aspect requiring attention is the attitude and the approach to innovation. It is very important that we should first change our outlook towards innovation and should not restrict or associate it with the word 'jugaad'. **We have the innovative mind but not the innovation-conducive environment or culture**…There is a need to have an effective innovation ecosystem in order to unleash the country's full potential. The creation of a vibrant innovation ecosystem requires several things, with talent being the primary requirement. The present scenario of things in India requires a shift in mindset from the traditional paths to

encouraging risk-taking and challenging status quo. Universities and colleges have a significant role to play in developing and shaping this kind of talent base…" [63]
Rishikesha T. Krishnan, Professor, IIM Bangalore has published wonderful research paper titled "The Evolution of a Developing Country Innovation System during Economic Liberalization: The Case of India" (2003) stated that "Among developing nations, India has **one of the strongest bases** of scientific and technical manpower and infrastructure for research and development. This base was built largely by the government and resulted in **significant achievements in strategic sectors such as atomic energy and space**. However, in the over-regulated and internally-focused economic policy regime that was in place till the late 1980s, this scientific and technological base **did not**, barring a few exceptions, **translate into significant industrial innovation**. Existing firms did not feel the pressure to, or see any benefit in, making serious efforts at technological innovation, and technological capabilities remained localized in research laboratories that were isolated from the system of industrial production… In spite of being a poor country, India had, since its independence in 1947, **devoted scarce resources** to the development of a science and technology infrastructure and a high quality system of higher technical education. While this enabled the country to make **significant progress in strategic sectors such as space research and atomic energy**, the **benefits did not percolate into the industrial sector**. A major reason for this was that in a protected and inward-looking economy there was **little need or incentive for innovation**." [396]

The World Bank Report "Unleashing India's Innovation" stated that "**India has many islands of excellence**. Still, it **falls behind the global frontier in most sectors of its economy**. Thus, innovation in India should not be thought of as simply shifting outward the global technological frontier, but as improving practices across the entire economy. Innovative activities are not restricted to new products but include innovations in processes and organizational models…Indicators of India's **capacity for innovation highlight its potential** and the links among innovation, productivity, and competitiveness. **India's stock of scientists and engineers engaged in R&D is among the largest in the world.** India is emerging as a global center of innovative automotive design. But another critical innovation input is domestic R&D spending, which in India has never exceeded 1 percent of GDP. However, the sizable increase in R&D activity by multinational corporations (MNCs) in India since 2002 has had a significant impact on total R&D spending. Moreover, acquiring new technology has a stronger correlation with productivity than does R&D spending. By far the most important channel for absorbing knowledge is through the use of new machinery and equipment. India has a strong record in producing basic knowledge, as proxied by internationally refereed scientific and technical publications. It has also experienced a significant increase in patent applications. Overall, India appears better at producing basic rather than commercializable knowledge. Still, the efficiency of its R&D spending, as measured by the relative costs of a scientific publication or a U.S. patent, appears higher than in comparator countries. [208]

In another great research paper by Rishikesha T. Krishnan, Professor, IIM Bangalore (34 pages) titled "India: Uneven Innovation Amid a Noisy Democracy" (2003) stated that "An overview of business innovation reveals that some sectors, notably automotive and pharmaceuticals, have seen innovation across business functions, but **innovation is not yet widespread across Indian industry**. Barring some significant exceptions, **Indian companies seem to be stuck in a**

paradigm of jugaad (creative improvisation) rather than embracing more systematic methods of innovation. In spite of India's demonstrated prowess in information technology, adoption of information technology by firms in India is low by global standards. Further discussion explores the reasons why, despite the significant foreign direct investment in R&D which India is recipient of, multinational R&D centres in India tend to be **disconnected from the broader innovation system**. The legal framework for the protection of intellectual property rights has been strengthened in recent years, but procedural challenges and inconsistent application of the rule of law make enforcement of these rights difficult. An overview of social and policy innovation suggests that these are bright spots but that the challenges posed by the scale and scope of India problems are daunting." [399]

The **private sector plays a central role in the innovation system**. It has its own mechanism of identifying prospective technologies that need to be developed, invests to develop those technologies and adopts market strategies for their commercialization. Importantly, these processes are not done in isolation. They involve interaction with other firms, with the public sector institutions and also with the market. In such a framework, market provides the necessary information that leads to new concepts… Finally, **human capital arguably forms the main pillar of an innovation system**. Scientists and engineers are the ones who implement new concepts and strive towards new technologies. Needless to mention, education system ensures a functioning innovation system by providing quality human capital. Therefore, an **innovation system is supported by the overall education system as well**. [397]

India also has thrived in the new age of globally networked innovation, emerging as a major source of

- Drug-discovery work
- Semiconductor
- Software
- Medical equipment
- Auto part design

Companies in India also have excelled at an **"inclusive" approach to innovation** that addresses the needs of the **low-income masses**. Indian companies have developed **innovative business models** selling **high-quality but ultra-low-cost goods and services** ranging from

- Cellular phone services
- Simple passenger cars
- Computers
- Surgical procedures etc. [225]

Mark Fidelman, CEO, Raynforest stated that "The biggest advantage Western entrepreneurs have over Asian, and specifically Indian entrepreneurs, are that their **innovation support systems are mature and systematized**. By that I mean if an entrepreneur has a "killer app" and wants to make it a reality, they have access to the resources, support, funding and mentorship to create a solution, build a company around it, structure the appropriate corporate governance, line up the relevant strategic partners and take their product and/or service to market. **Fragments of this ecosystem exist in India**, but compared to the US, **India's innovation infrastructure lacks the organized components** to create a Google, Apple, FaceBook, Microsoft, GE, Microsoft, or even the next generation of MySpace, YouTube or Twitter." [211]

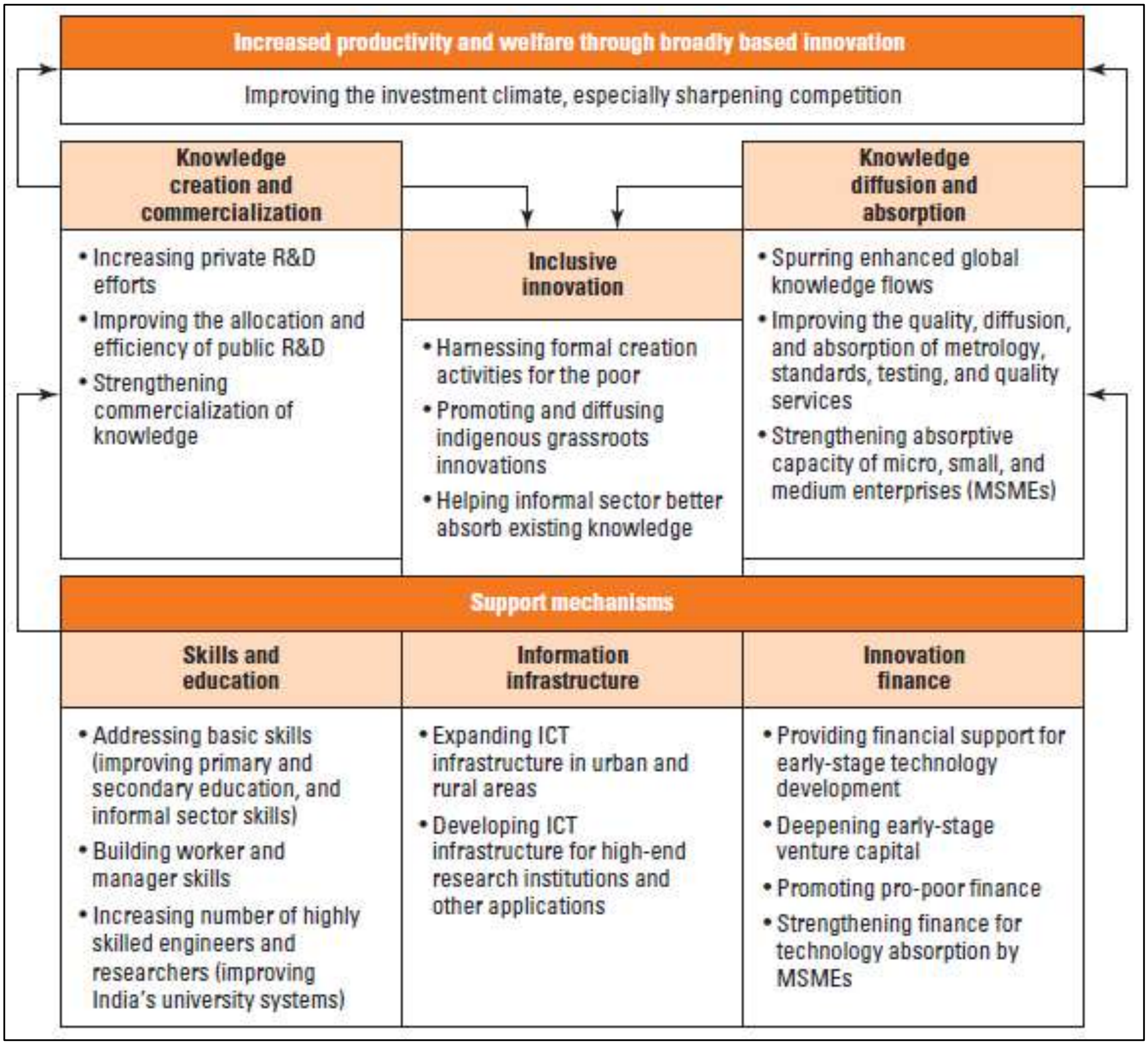


Fig. 10.5: World Bank Report: Unleashing India's Innovation Potential [208]

Fig. 10.6: India's Missing Innovation Ecosystem [211]

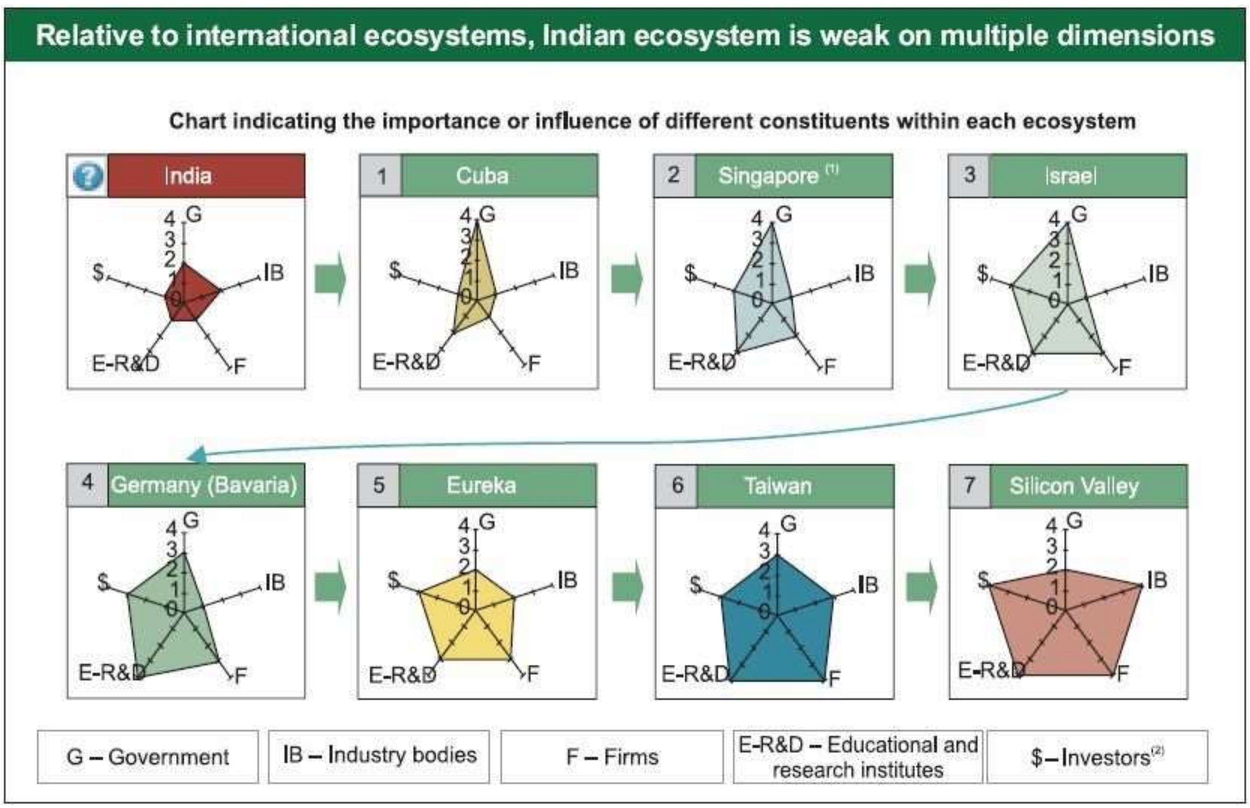


Fig. 10.7: Comparison of Innovation Ecosystem of different countries (source NASSCOM-BCG Innovation Report 2007) [212]

Let's see above diagram. Before we interpret the Innovation Ecosystem's dashboards, let's look at what the 5 dimensions stand for. As the picture shows, the 5 dimensions stand for

1. Government
2. Industry bodies
3. Firms
4. Educational and research institutes
5. Investors.

In the above diagram, the top row shows innovation ecosystem of India, Cuba, Singapore and Israel. The bottom rows shows that of Germany, Eureka, Taiwan and Silicon Valley. Among all the exhibits, **India happens to have the poorest ecosystem** while Silicon Valley has the most robust one. [212]

10.3. Views of Dr. R. A. Mashelkar, Former Director, CSIR

Dr. Raghunath Mashelkar, Former Director CSIR while answering the question "**According to some estimates, barely 25% of Indian companies invest in R&D and innovation. Why are they hesitant?**" said that "Innovation-led growth is something that's new to most companies. That is the challenge. Companies which realize that innovation is an option have made some investments. Reliance, Thermax, KPIT and Marico all have innovation councils. They didn't three years ago. This is not just technological innovation. The next round of growth, especially non-linear, will come inorganically or through innovation. Innovation as a way of life is new to Indian companies." (2014) [119]

10.3.1. Five Point Agenda for the Indian Decade of Innovation

Dr. R A Mashelkar, Former Director CSIR stated the five point agenda for the Indian Decade of Innovation as follows:

- Create a 21st Century National Innovation Ecosystem
- Launch an Inclusive Innovation Initiative
- Build Innovative Indian Institutions
- Build Innovative Indian Industry
- Build Innovative Indian Minds as well as Mindsets [229]

10.3.2. India Lacks a Powerful National Innovation Ecosystem

CSIR's "New Millennium Indian Technology Leadership Initiative" gave the challenge and funding for the creation of a low cost computer to Vinay Deshpande of Encore. He created Mobilis, a mobile personal computer. But the first Mobilis will be produced this year in Malaysia and Brazil and not in India. Due to the limitations in India's patent laws the phytopharmaceutical breakthrough medicine on psoriasis by Piramal Life Sciences will be commercialized first in the west, not in India. Why do we fail in completing the journey from an Indian mind to an Indian market place? Because **India lacks a powerful national innovation ecosystem.** [229] [230]

10.3.3. Create a 21st Century National Innovation Ecosystem

The **essential elements** of a powerful ecosystem comprises physical, intellectual and cultural constructs. Beyond mere research labs it includes

- Idea incubators
- Technology parks
- Conducive intellectual property rights regime
- Enlightened regulatory systems
- Academics who believe in not just 'publish or perish', but 'patent, publish and prosper'
- Potent inventor-investor engagement and
- Passionate innovation leaders.

The **essential elements** of ecosystems also involve

- Organizational autonomy & flexibility
- Institutional integrity
- Risk capital
- Web access, utility & tools
- Multi-disciplinary collaborations
- Incentivized young talent engagement with diaspora &
- Global - talent innovative media and outreach programs

The **role of the Government** will be to drive innovation through

- Skills and education policy
- Create systems of innovation in public service delivery
- Create a roadmaps for innovation
- Facilitate connections between universities, manufacturers, users and regulators
- Fund & drive high quality research & business innovations
- Bring appropriate strategic research to consumer market
- Promote innovative policies & places
- Facilitate exchange of innovations between public and private and finally
- Initiate nationwide innovation movement. [229] [230]

10.3.4. Key Challenges

The key challenges faced by India's innovation ecosystem and entrepreneurship in general are listed and described below:

1. **Fragmented policy and policy implementation**: There has been no comprehensive policy focusing on innovation and entrepreneurship so far. Also, the mechanisms to operate existing, fragmented policies were not uniform, which resulted in gaps in understanding and failure to achieve the desired effects of such policies. [236]
2. **Inadequate funding of R&D**: Little national funding is available for R&D: from 2011 to 2012 it was only 0.88% of gross domestic product. Consequentially, even less funding is available to the academic and R&D institutions. Out of the total R&D expenditure incurred in the country, about 63% of the expenditure is incurred by the government itself and the total R&D

expenditure incurred by industry altogether is equivalent to the amount just one global multinational spends on its in-house R&D. [236]

3. **Difficult and lengthy funding procedures**: Although funding is available from banks and public sources the procedures for accessing such funding are often complex, cumbersome, lengthy, and bureaucratic, in other words, not conducive to innovation and entrepreneurship. Moreover, despite these difficult and lengthy procedures, the system seeks immediate returns. However, the returns from innovation are often uncertain, late, or not quantifiable immediately. [236]
4. **Angel, venture capital, and seed funding**: Despite 100 angel networks operating in India (e.g., Indian Angel Network; Mumbai Angels), only tens of deals are made each year, according to the "Report of the Committee on Angel Investment & Early Stage Venture Capital" (Planning Commission, 2012). For such a populous country, this magnitude of deals is very low compared to the numbers from abroad and fall short of India's requirements. The report also indicates low levels of early-stage venture capital investment: around US$ 240 million per year. And, here also, there are only few hundred deals per year. Indian angels are constrained by regulations that make investment and exit cumbersome (Planning Commission, 2012). [236]
5. **Weak linkages between stakeholders**: The linkages between industry, especially medium and small-scale enterprises and R&D or academic institutions are weak. Industry requires proven technologies, but the institutions can only offer technologies at considerably earlier stages (i.e., at mostly a laboratory or pilot scale), meaning there is still much work to be done to bring the technologies to market. There is also considerably less funding and mentorship support available from the private sector. There is no easy exchange of manpower between the industries and academia or R&D institutions, which limits their capacity for mutual understanding and technology transfer. [236]
6. **Non-conducive education system**: The general education system is still too focused on grades and careers and is not oriented toward innovation and entrepreneurship. This situation is further worsened by the inherent problems of lack of infrastructure and good facilities in the educational institutions; delays in the funding system; and delays in the funds or other support reaching innovation projects. While industry craves solutions to their problems, the academic institutions are generally too busy performing routine academic exercises, churning out educated manpower that is often ill suited to either innovative industries or entrepreneurship. However, exceptions to this general view include a few high-end academic institutions such as Indian Institutes of Technology and similar institutions. [236]
7. **Poor infrastructure facilities in villages**: Basic infrastructure facilities such as electricity, Internet, roads and rail, and even the availability of a skilled workforce, are not evenly distributed in India and often weak in smaller cities or towns and rural parts of the country. Thereby, there is less scope for innovation and entrepreneurship to flourish in such areas. In most cases, innovators and entrepreneurs must travel long distances – at their own expense – to receive mentorship or other support. [236]
8. **Risk aversion among entrepreneurs**: Indian entrepreneurs often seek established technology as a basis for starting their business; they are hesitant to take on innovative ideas because of the risks involved, including the low availability and high cost of funds that often arrive too late. As a result, they look for minimum risk and quick returns. The potentially higher returns from innovation take time to realize, and not enough entrepreneurs are willing (or able) to accept the risks. [236]

9. **Inadequate protection of intellectual property rights**: In India, the intellectual property regime is weak. Innovators do not generally seek protection for their intellectual property unless forced to. For most entrepreneurs, patents and other forms of protection take too long and cost too much. Patent literacy is very low, even among educated innovators, and there is a lack of expert help available, except in the medicine and pharmaceutical industry. [236]

10.4. Nature and Elements of Indian Innovation Ecosystem

In 2007, Angathevar Baskaran, and Mammo Muchie have published a wonderful research paper "The Making of the Indian National Innovation Systems: Lessons on the specific characteristics of the domestic and the external co-evolutions of technologies, institutions and incentives". This research publication has nicely explained the Indian Innovation Ecosystem. I would like to include few points from this research work. One should read the entire 36 pages research paper for detailed information.

India's strategy for building its national system of innovation has borne always a **dualistic and lopsided feature** in terms of

- Priorities for science and technology selection and foresight
- Policies for supporting science, Technology and Innovation
- Creating institutions and their linkages
- Knowledge and learning
- Capability and training
- Diffusion and incentives

Despite its significant achievements in areas such as

- Building strong industrial and R & D base
- Establishing a large number of science and technology institutions and
- Creating large pool of scientists and engineers

The **Indian national innovation system has been criticized for its low quality manufactured good and inability to eradicate poverty**. [237]

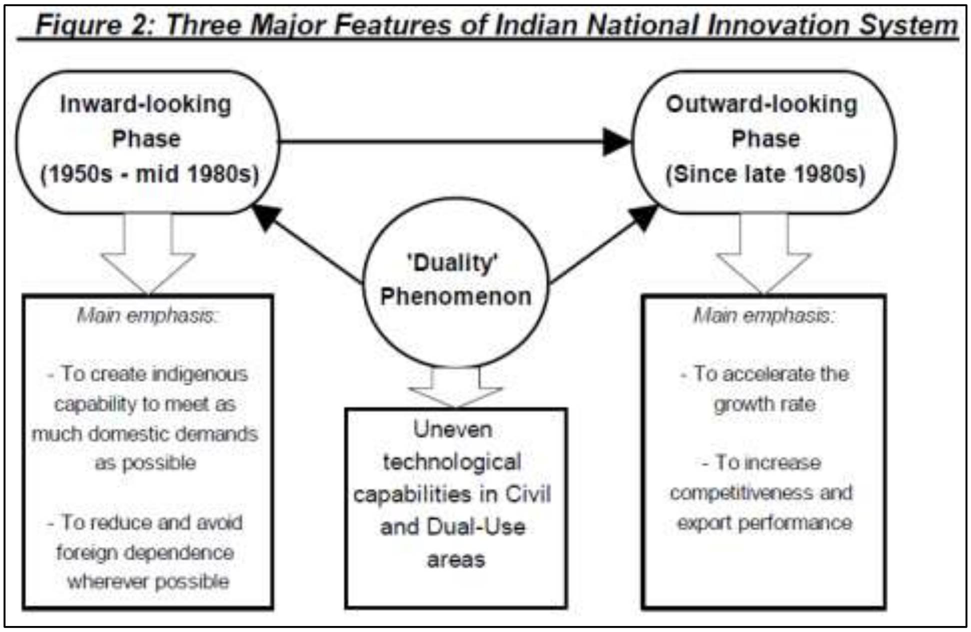


Fig. 10.8: Major Features of Indian National Innovation System (NSI) [237]

10.4.1. Phase 1 (1950-80): Self-Reliance

Indian national innovation system (NSI) that evolved between **1950s and mid-1980s** was driven by two major factors;

- ‘blind faith’ in science and technology; and
- An inward-looking policy of ‘self-reliance’.

The principal policy objective behind India’s industrialization effort has been ‘self-reliance’. Jawaharlal Nehru, Then Prime Minister, said that India could not be economically or politically independent unless it strengthened its scientific and technological capacity. Indian leaders feared the domination and influence of foreign firms if free and unrestricted entry were allowed. Therefore, India’s ‘self-reliance’ policy was **defensive and inward looking** rather than outward looking. **India aimed to create local technological capabilities to meet mainly the domestic demands and reduce foreign dependency rather than developing an industry that should be competitive in the global market**. This fundamental factor determined the **shape and efficiency of Indian innovation system in Phase I**. To achieve **self-reliance**, India implemented a number of measures such as

- Industrial policy clearly defining the roles of private and public sectors
- Regulation of private investment through industrial licensing
- Regulation of foreign private investments and
- Regulation of technology imports to encourage indigenous research and development.

This led to the development of indigenous R&D capabilities and local machine tools and industrial equipment suppliers as little or no technical assistance was received from foreign technology suppliers. [237]

There were two major developments in the industrial sector.

- On the positive side, India has **developed relatively a high level of indigenous technological capabilities** to design and operate plants in number areas of capital and intermediate goods sectors**.**
- **On the negative side, Indian firms hardly made major innovations to their products to establish a significant and sustainable export market.** They mainly produced cheap and reliable products for the domestic market and a number of firms started in-house R&D to develop such products by adapting imported technology.

By the early 1970s, most of the public R&D institutions made effort to catch up with research in the developed countries and conducted research at the frontier level. Although they produced scientific knowledge and created a strong basic research base, often they did not contribute directly to help solve socio-economic problems of the country. **The government's attempt to force firms to buy technology from public R&D institutions** was given up in 1975 and by the early 1980s India started **liberalizing its policies towards import of 'new technology'**. [237]

10.4.2. Phase 2 (Since late 1980s): Outward Looking NSI

By the mid-1980s dissatisfaction with the performance of the economy started a shift towards an **outward-looking National Innovation System** (NSI) to achieve competitiveness and higher growth. This shift became clear when the industrial policy liberalization was announced in 1991 that led to major changes in the areas such as

- Industrial licensing
- Foreign investment
- Foreign technology agreements
- Public sector and Monopolies and Restrictive Trade Practices Act.

This marked a clear shift from import regulating activity to export promotion activity. [237]

The liberalization of policy regime has had a significant impact on the performance of Indian NSI.

- The foreign technology import, manufacturing operations, and investment have increased since the 1990s.
- **One of the significant developments is the opening up of R&D centres by MNCs in India and forging of collaborative relationships with Indian S&T institutions**.
- Another development is the **outsourcing of operations by foreign companies to India**, mainly in the service sector. This seems to be increasing as this helps foreign companies to cut cost and enhance their efficiency, because of high-skilled and highly qualified workforce available in abundance in India. The complexity and volume of outsourcing to India seems to be increasing. In the era of 'knowledge economy' it is an important development, as skills are as much valuable as technology and products. [237]

In the area of export and competitiveness, progress appears to be slow in many industrial sectors. However, the IT sector, which emerged in the 1980s and 1990s as a major sector has witnessed significant export growth, particularly in the area of software. There is a general perception that the availability of abundant skilled labor is the main reason for this. **The answer is more complex than this.** India **missed the semiconductor revolution in the 1970s, due to protectionism and inter-departmental turf war. India learned valuable lessons and was careful not to repeat the mistake in the 1980s when the computer/IT revolution started**. Since early 1980s, that is, long before the major liberalization in the 1990s, significant policy measures were taken to promote and expand the computer industry. The Computer Policy was announced in 1984 that removed capacity curbs, liberalized the licensing system and import duty to enable economies of scale and increase competitiveness. The Electronics Policy 1985 noted that “the software content of electronics is increasing and India is most appropriately placed to take advantage of this" The computer industry was predominantly left in the private sector and competitive environment was fostered. Soon, hundreds of firms in all sizes emerged. This subsequently appears to have established India as a leading player in the software market in the 1990s. **India’s success in this sector was mainly due to intensive R&D effort by the companies and the presence of strong basic research capability in the country.** The liberalization of policy regimes in the 1990s has **demonstrated the potential of Indian innovation system in achieving a higher rate of growth despite persistent weaknesses of Indian innovation system such as continuing problems in forging closer linkages between R&D institutions and firms**. [237]

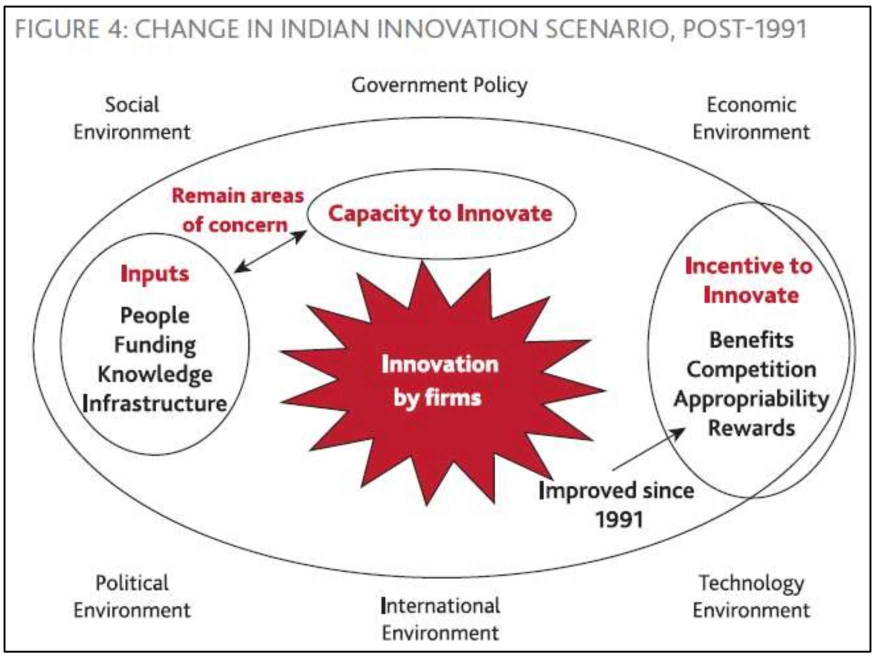


Fig. 10.9: Changing Indian Innovation Scenario since post 1991 [399]

The document published at Planning Commission, Government of India at website (related to Approach to the 12th Plan) stated that

- Science underpins most breakthrough initiatives, but beyond the domain of science, **innovations play a critical role in enhancing delivery of services and enabling access to improved goods**. In view of this, India needs to stimulate and strengthen its entire eco-system—the formal scientific and industrial system, as well as the **innovation eco-system**—to develop solutions for the country’s agenda of faster, sustainable and more inclusive growth
- A strong R&D sector is important not only for competitive growth but more importantly for addressing key strategic issues. **While public funded institutions are generating technology leads, their levels of utilization by commercial enterprises have been limited**. The present models of research funding in the country **do not facilitate the funding of projects in the private sector**, whereas **several global models do so**. Current fiscal incentives for attraction

of investments into R&D by way of tax benefits have led only to **marginal results** and the linkages between academia-research and industry remain under developed and weak. The challenge is how to create a vibrant landscape of Public-Private Partnership and an enabling framework for attracting **investment from the industrial sector into R&D system** and incentivize the same for linking development with deployment in the innovation and technology sector.

- **Intellectual property rights (IPR) have become extremely important in the new knowledge economy** due to global competition, high innovation risks, short product cycle, need for rapid changes in technology, high investments in research and development (R&D), production and marketing and need for highly skilled human resources." [160]

10.4.3. Performance of Indian NSI and Wrong Criticisms

India's National Innovation System (NSI) often faced criticism because of

- Its inefficiency that led to low rate of growth
- Its poor export performance and
- Relatively low quality of manufactured goods.

These criticisms, although valid, either ignored or deliberately failed to take into account the context of the evolution of national innovation system in India. Particularly in the first phase, the principal objective of India's economic and S&T policy regimes was creating indigenous capabilities in the industry to meet as much domestic demands as possible, and thereby reducing or avoiding undue foreign dependence. Although ritual mentions were made in policy declarations about exporting, **it was not the main driver of Indian innovation system in the first phase unlike the case of South Korea or Taiwan. Indian firms failed to export not because they were incapable, but because they "prefer to exploit local markets where they have factor cost and marketing advantages"**. Despite major flaws, there were significant achievements during the first phase of Indian national innovation systems. These included:

1. Creation of S&T infrastructure and the expansion of higher education with great emphasis on basic research;
2. Development of indigenous capability to produce a range of goods which even today many developed countries are not capable of;
3. Implementation of the Green Revolution to achieve self-sufficiency in food grains; and
4. Creation of the scientific and industrial innovative potential to compete at international market. [237]

Over the years, India **invested significantly in S&T infrastructure and R&D expenditure**. Its R&D investment is **comparable not only to developing countries like South Africa and China but also to some developed countries**. This created a vast network of basic S&T institutions and infrastructure that led to significant output in terms of number of engineers, scientists, and technical persons. [237]

An efficient innovation system is where technological accumulation and progress is also accompanied by higher growth performance of the industrial sector. During Phase I, the industry has witnessed significant growth, although "**the overall growth rate remained much below the plan targets and also below the achievements of several newly industrializing countries such as South Korea and Brazil**". Initial high growth rate gave way to stagnation since mid-1960s. However, this changed since mid-1980s when India started liberalizing its industrial and technology policy regimes. Since then, India's industrial growth has been significant. **The relative inefficient performance in Phase I appear to be largely because of rigid policy regimes**. The liberalization in Phase II aimed to accelerate investment, growth, and employment appears to have produced mixed results (both positive and negative). [237]

10.4.4. Positive & Negative Sides of Indian NSI

On the positive side, a number of developments could be identified. These include the

- Significant GDP growth
- FDI inflow,
- Technology transfer and
- Global / International R&D
- Export performance
- Emergence of ICT sector as one of the leading sector
- Employment growth and
- Other socio-economic development. [237]

Indian National Innovation System (NSI) has been facing number of serious challenges and problems such as

- High level of illiteracy
- Imbalance in income levels
- Socio-economic development across different states and within states (provinces)
- FDI inflows
- Weak linkages between R&D institutions/ university and industry
- Lack of product innovation culture among the firms
- Lopsided growth with ICT sector dominating others
- Problems with Education and Skills [237]

Yet, innovation is much more than just ideation. The initial idea is, at best, a seed of innovation. An idea needs to be experimented on and validated, combined with other ideas, and put into practice before it can be called an innovation. While a **functioning democracy prevents ideas from getting stifled, the evolution of an idea into an innovation can happen only if the institutional environment is supportive**. Unfortunately, the **cost of innovation** and entrepreneurship in India tends to be **high** because of a number of voids and distortions in the institutional environment. These include a lack of high quality infrastructure, absence of enough skilled manpower, and corruption across the government and regulatory framework. In addition, these institutional voids are in turn related to the malfunctioning of the social, political, and economic system in India of which democracy is an important bulwark. [399]

10.5. India: National Innovation System, Policies & Strategies

The following diagram highlight the Indian Technology Innovation System. The detailed information about each Technology Innovation System is available in the research paper "Indian Innovation System: Perspective and Challenges" by Ashwani Gupta and P.K. Dutta. [395]

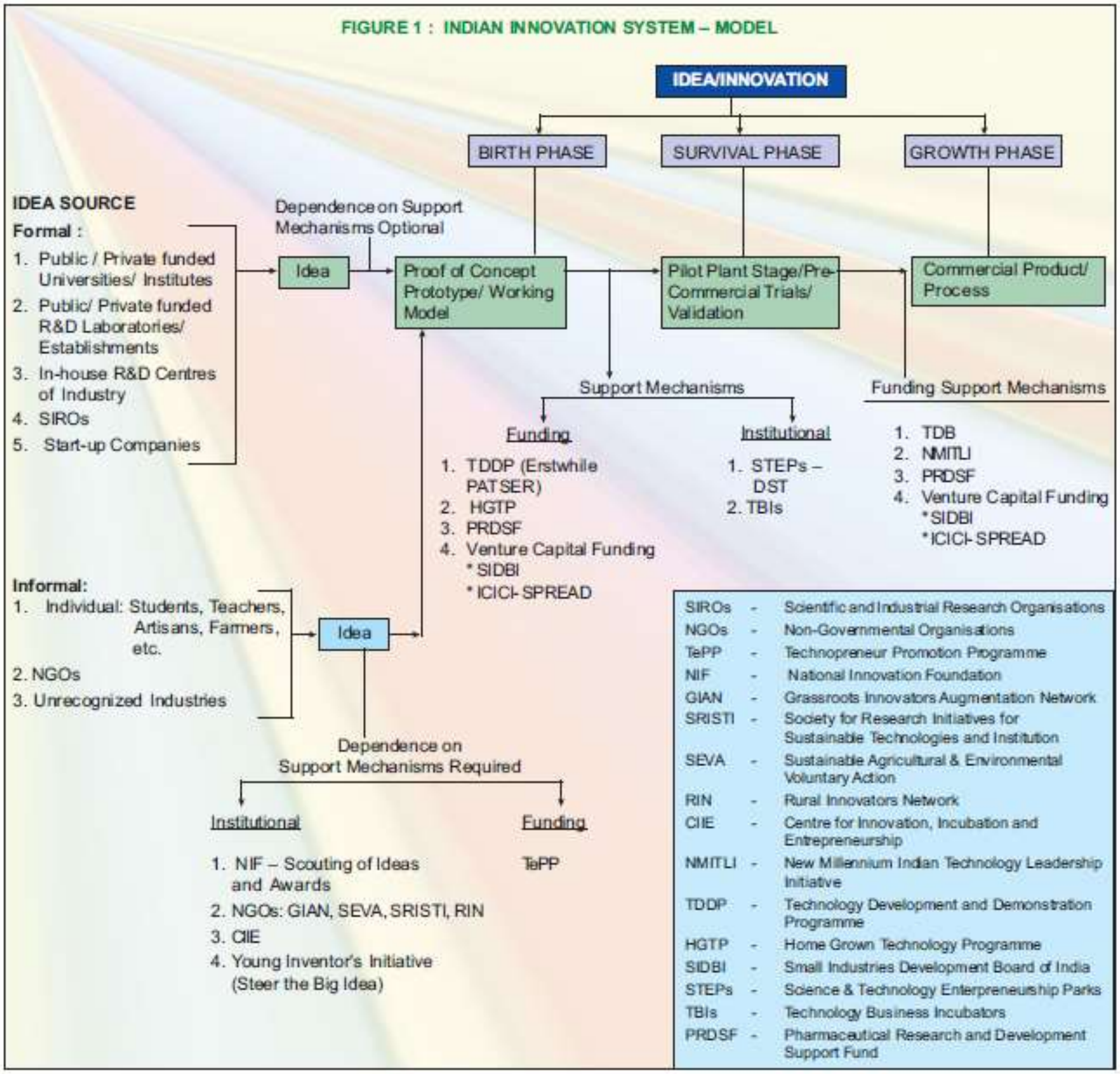


Fig. 10.10: Indian Innovation System [395]

Fig. 10.11: Government policies and schemes for Inclusive Innovation [231]

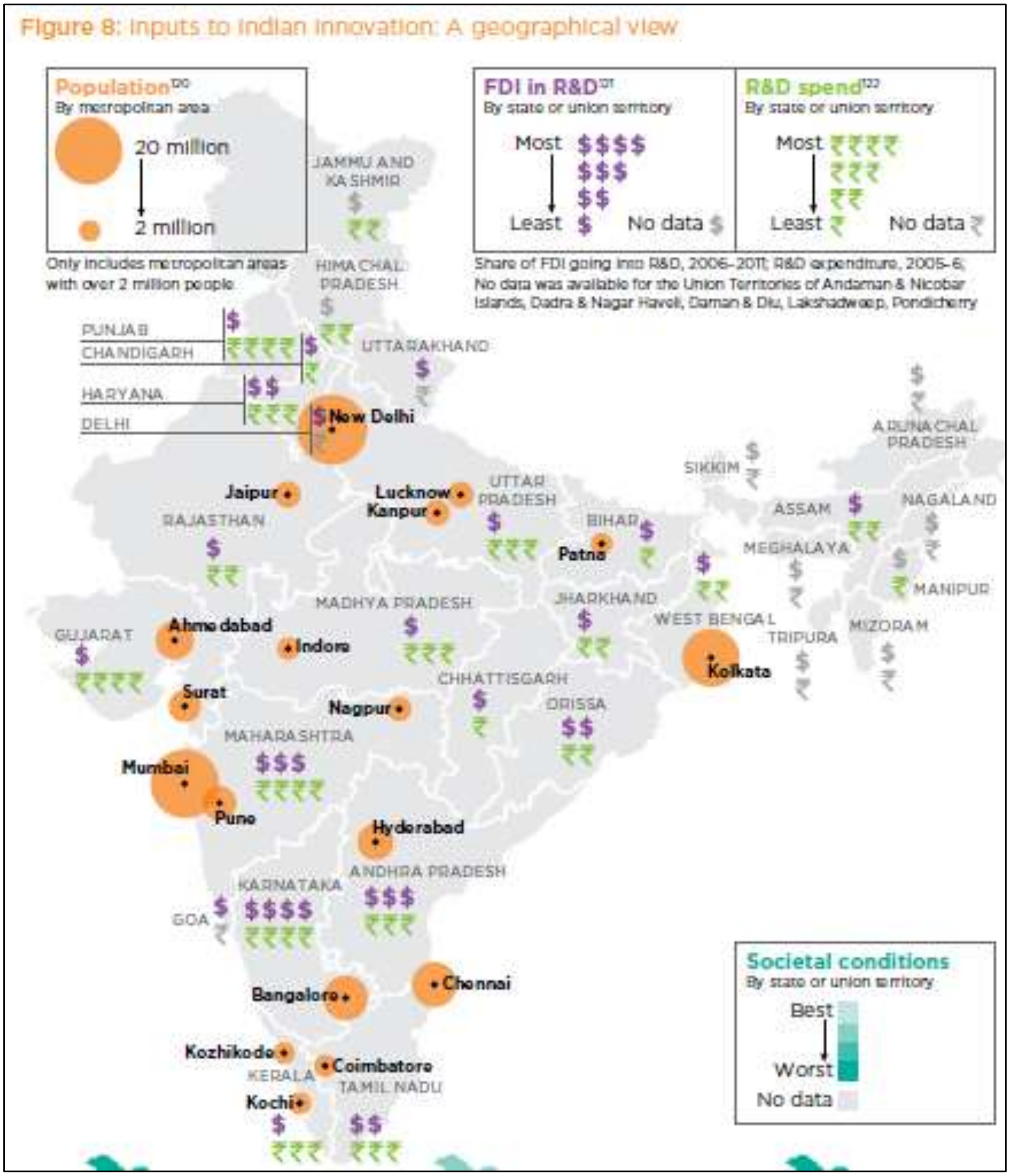


Fig. 10.12: Input to Indian Innovation [76]

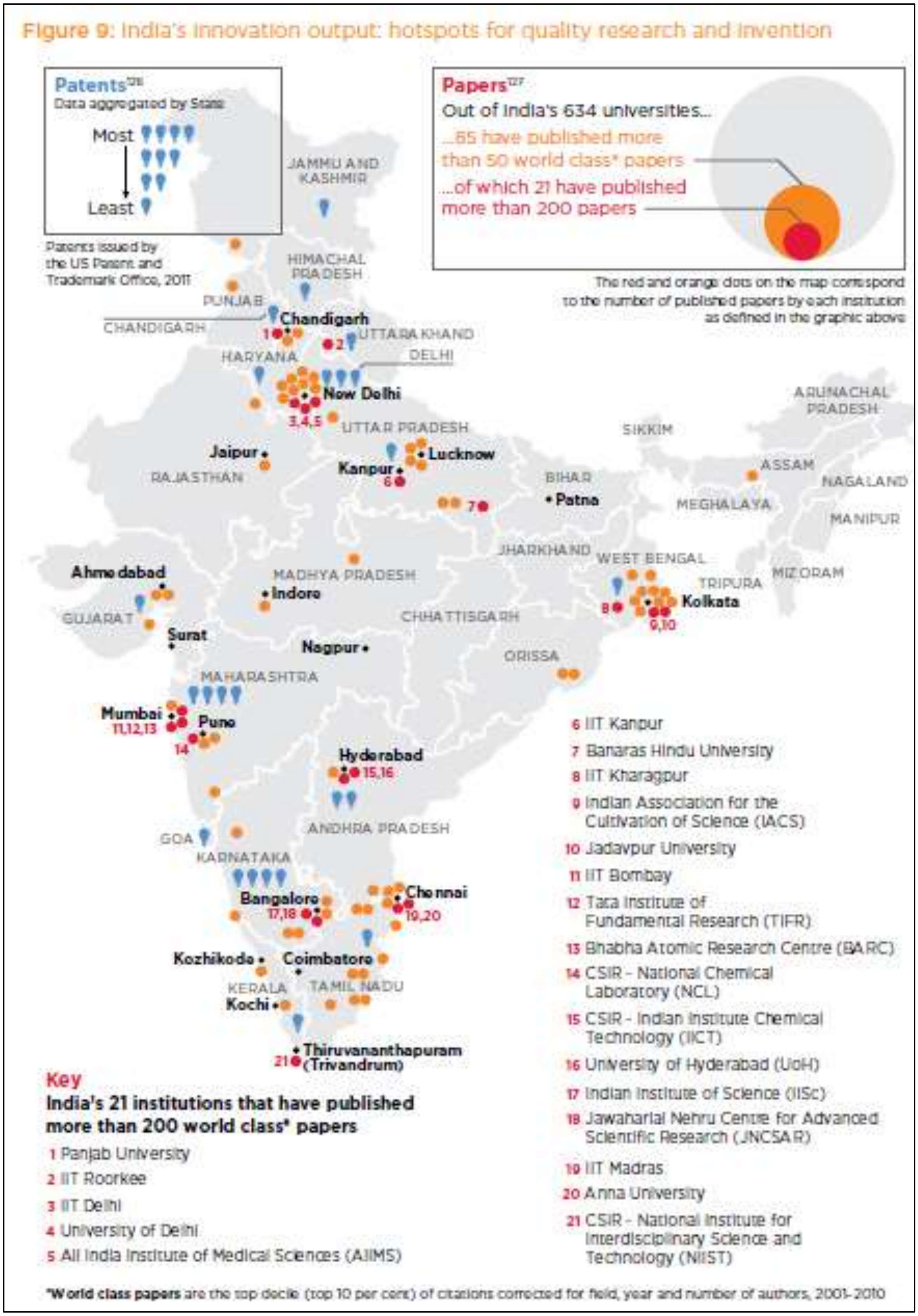


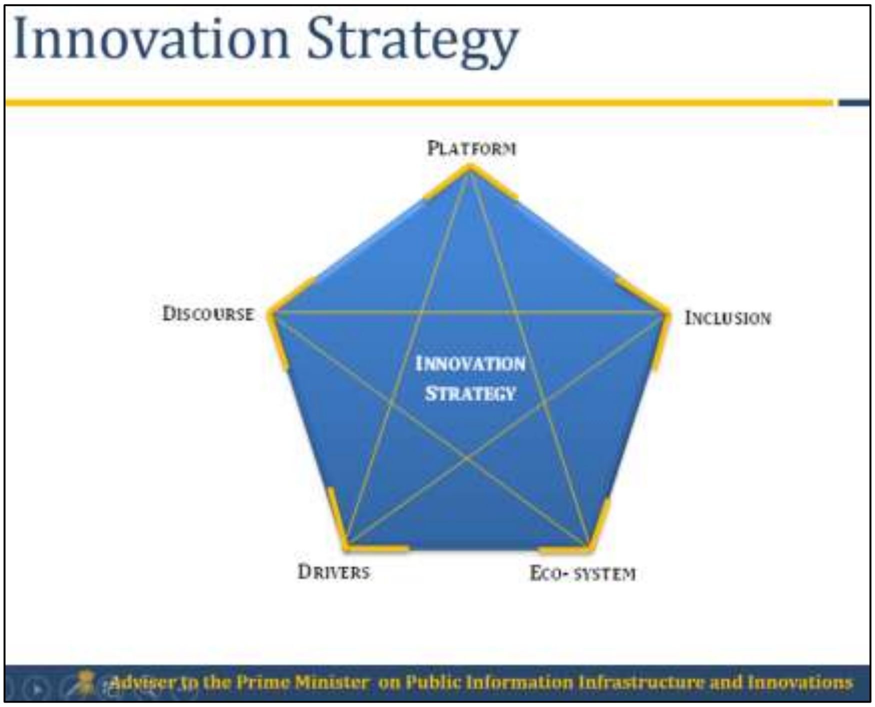
Fig. 10.13: India’s Innovation Output [76]

10.5.1. India Innovation Decade 2010-20

After the President of India declared 2010–2020 the "Decade of Innovation," STIP 2013 proposed new schemes such as the "Risky Idea Fund" and "Small Idea Small Money." The government launched the India Inclusive Innovation Fund (IIIF) under the Public-Private Partnership (PPP) model, with the government chipping in with just two per cent of the budget. **But private partners have hardly evinced any enthusiasm to invest in this scheme.** Is the government serious? The policy paralysis in science and technology innovation can be seen from the dismal amount of money allocated to a dozen innovation schemes under the Department of Science and Technology (DST) and the Department of Scientific and Industrial Research (DSIR). Out of the total budget of Rs. 2,998 crore given to the DSIR in 2011, **only Rs.155 crore went to innovation schemes**. And, of the Rs. 2,349 crore given to the DST in 2012, **only Rs.57 crore went to innovation schemes**. [234]

The government S&T policies are as follows:

- Science policy (1956)
- Technology Policy (1983)
- Science & Technology Policy (2003) and
- Science, Technology & Innovation Policy (2013) and a few Policy Resolutions in between. [235]


Innovation Strategy
PLATFORM
DISCOURSE
INCLUSION
INNOVATION STRATEGY
DRIVERS
ECO- SYSTEM
Adviser to the Prime Minister on Public Information Infrastructure and Innovations


Strategy
Provide broader PLATFORM for Innovations everywhere to include:
Products
Services
Organizations & Institutions
Processes
Research and Development
Science & Technology
Governance
Social and Cultural
Mindset
National/ State/ Sectoral Councils


Strategy
Encourage Innovations for INCLUSION aimed at the Bottom of the Pyramid:
Awareness
Access
Affordability
Availability
Scalability
Sustainability
Quality
Pervasive Growth
Innovations for/by the people
Innovations for the BOP


Strategy
Foster necessary ECO SYSTEM
Incentives & Awards
Innovation clusters at universities
Innovative business clusters
Innovation in MSMEs
Organizational Autonomy & Flexibility
Policies & Programmes
New Institutions
Risk/ Venture Capital
IPR/ Patents
Web & ICT as tools

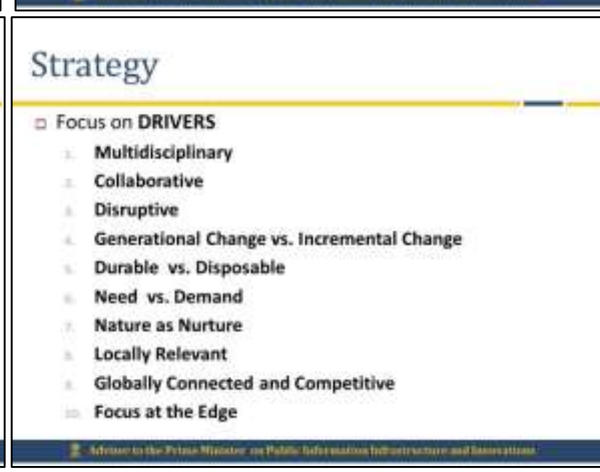

Strategy
Focus on DRIVERS
Multidisciplinary
Collaborative
Disruptive
Generational Change vs. Incremental Change
Durable vs. Disposable
Need vs. Demand
Nature as Nurture
Locally Relevant
Globally Connected and Competitive
Focus at the Edge

Fig. 10.14: Presentation by Sam Pitroda, Former Advisor to PM: Innovation Strategy India [217]

10.5.2. Science, Technology and Innovation (STI) Policy 2013

10.5.2.1. Overview

India's new Science, Technology and Innovation (STI) Policy was released in January 2013. It envisions placing India among the top five global scientific powers by 2020. It proposes to use STI for faster, sustainable and more inclusive growth with a focus both on STI for people and people for STI. [228]

It plans to boost innovation through research and development (R&D) driven by private sector participation, publishing more research papers, achieving gender parity in S&T and global cooperation. A Strong and viable Science, Research and Innovation system for High Technology led path for India (SRISHTI) are the goal for the STI policy. Here are the main objectives of the Science and Technology Innovation Policy 2013: [228]

- Budget: Increasing the R&D spending to 2% in next five years' time through PPP; creating conductive environment for encouraging private sector investment in R&D. This seems attainable as the industrial R&D investment grew by 250% and the sales by 200% between 2005 and 2010. [228]
- Research & Manpower: Promotion of spread of scientific temper amongst all sections of society; attracting talented and bright minds towards careers in science, research and innovation; increasing the number of R&D personnel by 66% in next five years; creating environment for women to enter in R&D field; and setting up inter university centers, bringing together different disciplines of humanities and science together. The government plans to increase the share of global scientific publications from 3.5% to over 7% and quadruple the number of papers in top 1% journals from the current levels. [228]
- Business: Identifying 10 sectors of high potential and putting more resources into them for STI; increasing by two folds the global share of high tech products; increasing R&D intensity in service sector, small and medium scale enterprises; sharing the risk on R&D investments with private sector; providing new financing mechanisms for entrepreneurs; creating a public procurement policy that favors indigenous innovations; achieving synergy between R&D policy for agriculture vs. STI policy. [228]
- Climate Change: Active role in implementation of National Action plan for Climate Change (NAPCC); and providing incentives for green manufacturing. [228]
- PPP: Setting up of
    - a National science, Technology and innovation foundation to facilitate investments in S&T projects under PPP mode and large scale R&D facilities under PPP mode
    - Establishing technology business incubators and science-led entrepreneurships;
    - Treating private sector R&D institutions at par with public sector institutions for giving public funds. [228]
- IPR: Modification of Intellectual Property Rights (IPR) for social goods and IPR generated under PPP; setting up of a regulatory and legal framework for sharing IPRs between Investors and inventors. [228]
- Participation: Encouraging participation of all STI stakeholders including
    - Women and differently-abled and disadvantaged sections of society;
    - NGOs who would play pivotal role for delivery science-tech-innovation outputs especially related with rural / grassroot level;
    - State Governments by setting up state specific plans and strengthening the State Sci-Tech Councils / Boards and fine-tuning five-year plan schemes in response to rapid changes in S&T;

  - International partners by forging strategic alliances both bilateral and multilateral. [228]
- Public awareness: Releasing white papers on new science projects to generate public awareness about the ethical / social / economic implications of science-tech-R&D initiatives. [228]

The Policy outlines several measures, mechanisms and instruments to realize the Policy aspirations. [228]

10.5.2.2. Key Initiative

The **Science, Technology and Innovation Policy 2013** outlines the major policy initiatives to strengthen the innovation ecosystem and give a boost to the development of innovation-led entrepreneurship in India: [236]

"The guiding vision of aspiring Indian STI (Science, Technology, and Innovation) enterprise is to accelerate the pace of discovery and delivery of science-led solutions for faster, sustainable and inclusive growth. A strong and viable Science, Research and Innovation System for High Technology-led path for India (SRISHTI) is the goal of the new STI policy." (Ministry of Science and Technology, 2013). [236]

Below, the key initiatives of this policy are explored in light of the challenges identified in the previous section:

1. **Funding**: The policy announces an increase in the gross expenditure in research and development (GERD) from less than 1% to 2% of the gross domestic product over the next five years. It also states that a National Science, Technology and Innovation Foundation will be established "as a public-private partnership (PPP) initiative for investing critical levels of resources in innovative and ambitious projects" (Ministry of Science and Technology, 2013), thus attracting private sector investments in R&D. It further announces the establishment of a fund for innovations for social inclusion, "small idea-small money", and a "risky idea fund". These funds are designed to address the funding-related challenges described in the previous section. The policy does not mention angel or venture capital funding but the above measures will fulfill some of the requirements of innovators and entrepreneurs and the innovation ecosystem overall. It also addresses the "rigidities" in centrally developed plans for investment and assures a flexible approach that allows fine tuning of the government's five-year plans in response to rapidly changing science and technology, and it addresses the challenge of outdated procedures adopted for funds disbursement for innovative projects. [236]
2. **Strengthening the linkages between stakeholders**: The policy calls for "special and innovative mechanisms for fostering academia–research–industry partnerships" and facilitating the "mobility of experts from academia to industry and vice versa" (Ministry of Science and Technology, 2013). This initiative should help address the challenge related to linkages and should facilitate understanding within such partnerships. [236]
3. **Promotion of science**: The policy promotes the spread of scientific interest and understanding across all sections of society. The policy will "further enable school science education reforms by improving teaching methods, science curricula, motivating science teachers and schemes

for early attraction of talent to science" (Ministry of Science and Technology, 2013). In these ways, the policy addresses the need for educational reforms. [236]

4. **Risk taking ability**: The policy accepts risk as an integral part of a vibrant innovation system. The policy emphasizes risk sharing by the government, which is slated to "significantly increase private sector investment in R&D and technology development" and "new financing mechanisms would be created for investing in enterprises without fear of failure" (Ministry of Science and Technology, 2013). [236]
5. **Intellectual property**: The policy will seek to "establish a new regulatory framework for data access and sharing [and for the] creation and sharing of intellectual property. The new policy framework will enable strategic partnerships and alliances with other nations through both bilateral and multilateral cooperation in science, technology and innovation. Science diplomacy, technology synergy and technology acquisition models will be judiciously deployed based upon strategic relationships" (Ministry of Science and Technology, 2013). Thus, this initiative is very important for international collaborations. [236]
6. **Addressing the innovation value chain**: The policy also enables a holistic approach to the complex value chain of innovation by providing science and technology interventions at all levels of research, technology and manufacturing, and services in the areas of socioeconomic importance. In this way, the policy has a very positive note and expresses a desire to shape the future of India. With the advantages of a "large demographic dividend" and a "huge young talent pool", the policy foresees the achievement of national goals for sustainable and inclusive growth (Ministry of Science and Technology, 2013). [236]
7. **Participation in global R&D infrastructure**: The policy proposes the creation of "high-cost global infrastructure in some fields through international consortia models. Indian participation in such international projects will be encouraged and facilitated to gain access to facilities for advanced research in cutting edge areas of science. This will also enable the Indian industry to gain global experience and competitiveness in some high-technology areas with spin-off benefits" (Ministry of Science and Technology, 2013). [236]

The Science, Technology and Innovation Policy 2013 thus tries to join the fragmented pieces of the Indian innovation ecosystem and bring it into the sharper focus. It addresses the need to enhance scientific understanding and skills among the young and aspires to position India among the top five global scientific powers by 2020. It also links the contributions of science, research, and innovation with an inclusive growth agenda with the aim of forming a robust and focused national innovation system. Importantly the policy supports entrepreneurship driven by science, technology, and innovation with viable and highly scalable business models. A key mechanism is investment in young innovators and entrepreneurs through education, training, and mentoring. This positive signs indicate that the government has fulfilled its role on the policy front. Now, it will be up to all the departments of the government to build innovative delivery mechanisms to take the fruits of this policy to the people of the country. [236]

There are formidable challenges in realizing the goal, but as this article has shown, the Science, Technology and Innovation Policy 2013 is a big step in the right direction, because it addresses most of the key challenges in developing an effective innovation ecosystem. [236]

10.5.3. National Innovation Council (NInC)

The government of India had started National Innovation Council (NInC) to promote innovation at various levels. They had started

- Innovation Space: NInC has provided a framework for creation of innovation spaces at museums and has plugged these ideas into the 12th Plan via the Planning Commission
- Innovation Express
- National Knowledge Network: Government is building an IP Network with gigabit capabilities to connect 1500 nodes across the country for Education and Research to expand, excel & collaborate
- National Innovation Clusters
- **Tod-Fod-Jod** Centers at Schools and Colleges for Igniting Youth Innovations
- Setting up twenty Design Innovation Centres co-located in institutes of national importance
- Meta University
- National Innovation Promotion Service
- Innovation Centre in each DIET (District Institute of Education and Training)
- National Innovation Scholarships analogous to the National Talent Search Scheme.

National Innovation Council is providing huge funding for Innovative projects, programmes and university.

- “Innovative project’ would involve a one-time grant of up to Rs.25 cores.
- “Innovative programme” would involve a grant from Rs.25 up to 100 crores.
- “Innovation University” shall be eligible to receive a grant from Rs.100 crores up to a maximum of Rs.300 crores for a period of five years.

NInC believes the CICs should be outcome oriented and their performance measured/reviewed. The following criteria will be used to define success or failure:

- Patents (applied and granted)
- Research publications
- University spin-offs
- Businesses incubated and success rate
- Average year wise growth of incubated start-ups
- Extent or measure of industry collaboration
- Revenue generated through technology licensing
- Curriculum innovation initiatives
- Recognitions and awards received [31]

NInC has proposed to launch a $1bn government backed Innovation Fund to invest in promising projects. The latest news suggests it may be given $40m in FY2013 in addition to the $20m promised last year. This fund will be run by the Council for Scientific and Industrial Research with the support of the National Innovation Council. [31]

10.5.4. National Innovation Cluster

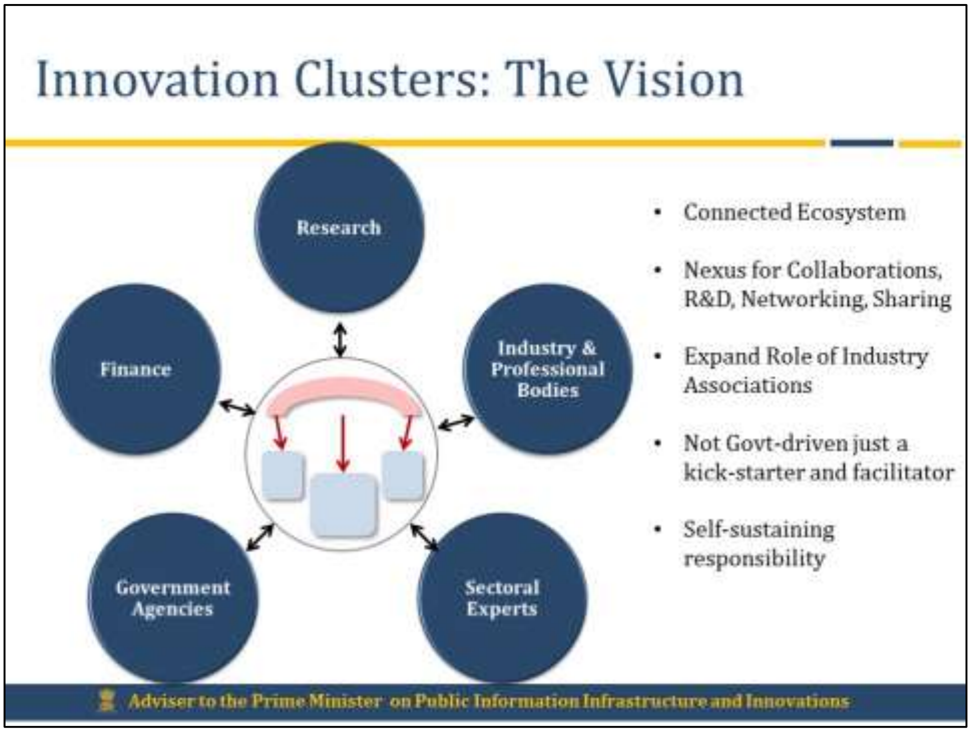


Fig. 10.15: Innovation Cluster Vision of India [217]

10.5.5. UGC Schemes

The University Grand Commission (UGC) has introduced various schemes to promote innovations in Indian universities like

- Schemes to improve quality of teaching and research at the universities and colleges
- Special Assistance Programmes (SAP) at various levels
- "Centre of Advanced Study (CAS)"
- Department of Special Assistance (DSA)" and
- "Departmental Research Support (DRS)" Programmes,
- Innovative Programmes to encourage the pursuit of excellence and teamwork.
- A scheme on Innovative Courses
- Inter-University Centres (IUC). In addition, the UGC established six IUC. The first IUC that was established by UGC in 1984 was the Nuclear Science Centre (NSC), in Delhi, later renamed as the Inter University Accelerator Centre (IUAC). The IUAC has been providing universities with opportunities to do internationally competitive research in different branches of science.
- The UGC has also identified 15 Universities under the Scheme "Universities with Potential for Excellence" during IX, X and XI Plan period. Those universities identified during IX Plan

period have been given Phase II of the UPE Scheme during the XI Plan period based on the peer evaluation. [631] [632]

Fig. 10.16: Indian Imitative for developing Innovation Culture [23]

10.5.6. National Innovation Foundation-India (NIF)

Building upon the Honey Bee network philosophy, the **National Innovation Foundation-India** (NIF), started functioning in March 2000 as India's national initiative to strengthen the grassroots technological innovations and outstanding traditional knowledge. Its mission is to help India become a creative and knowledge based society by expanding policy and institutional space for grassroots technological innovators. NIF is committed to look for grassroots innovators who have developed technological innovations in any field of human survival without any outside help. [118]

NIF helps them get due reward for their innovations and ensure that such innovations diffuse widely through commercial and non-commercial channels generating incentives for them and others involved in the value chain. With major contribution from the Honey Bee Network, NIF has been able to build up a database of more than **200,000 ideas**, innovations and traditional knowledge practices (not all unique) from over 555 districts of the country. Through the collaborations with R&D institutions, NIF helps in getting these innovations validated and converting them into value added technologies/products. [118]

NIF has **filed over 650 patents** on behalf of the innovators and outstanding traditional knowledge holders of which **thirty five patents have been granted in India** and **five in USA**. Micro Venture Innovation Fund at NIF has provided **risk capital for 191 projects**, which are at different stages of incubation. NIF has succeeded in commercializing products across countries in six continents apart from being successful in materializing seventy cases of technology licensing to eighty licensees with the help of partner agencies. [118]

NIF has proved that Indian innovators can match anyone in the world when it comes to solving problems creatively, where they perform better than rest is in generating greater sustainable alternatives by using local resources frugally. Those who see poor only as the consumer of cheap goods, miss the knowledge richness at grassroots level. The Grassroots to Global (G2G) model that NIF is propagating is all set to change the way the world looks at the creativity and innovations at grassroots. [118]

Table 1.5 The Enabling Environment for Innovation: Policies, Institutions, and Capabilities

Components of enabling environment	Policies	Institutions	Capabilities
Creation and commercialization of new knowledge	• Policies to promote more private R&D ◦ Intellectual property rights regime ◦ Matching grants ◦ Tax subsidies • Public spending on R&D ◦ National mission programs ◦ Competitive grants ◦ Peer reviews • Support for pro-poor innovations	• Public labs, universities • Private R&D labs • IPR institutions • Technology transfer offices • Science and technology parks • Technology incubators • Research and education networks • Specialized nongovernmental institutions • Grassroots networks • Early-stage technology development finance and venture capital	• High-level human capital for R&D (scientists, engineers, technicians) • Techno-entrepreneurship
Diffusion and absorption of existing knowledge in new locations	• Openness to global knowledge flows ◦ Trade ◦ Foreign direct investment ◦ Technology licensing policy ◦ Internet access • Foreign education and attracting the diaspora	• Technical information services • Technology upgrading • Productivity organizations • Metrology, standards, testing, and quality control systems • National research and education networks • Networks at cluster level • Technology absorption finance for micro, small, and medium enterprises	• Formal education and skills • Engineering consulting firms • Business support services
Broader investment climate	• Competition and trade • Regulatory policies, especially toward infrastructure • Entrepreneurship support • Good rule of law • Macroeconomic stability	• Efficient financial system • Flexible labor market • Effective courts and judiciary • Market-responsive formal education institutions and lifelong learning system	• Literacy • Secondary and higher education graduates • Managers • Entrepreneurs

Fig. 10.17: The Enabling Environment for Innovation: Policies, Institutions, and Capabilities [208]

Chapter 11: NSI Components: University, Higher Education System and National Laboratories

Hon. President of India Pranab Mukherjee said that "Our ***universities have to support an eco-system*** *where innovative ideas born out of novelty of the common man are mentored. To spur an innovation culture and to translate the slogan of 'inclusion in innovation' into a* ***workable framework****." [634]*

National laboratories continue to work with industry in ***patches****. Their predominant model still remains government funded R&D… The* ***public sector accounts for 70–80 percent*** *of India's total R&D investment, equal to 0.8 percent of GDP.* ***The bulk of that effort is mission-oriented R&D in defense, space, and energy****. [149] [208]*

Paula Mariwala Executive Director Seedfund says they can only replicate Silicon Valley in India by fixing the education system in India, since there are currently poor links between industry and academia across various sectors… The spirit of innovation has to permeate all sectors of economy from universities, business and government to people at all levels. [679]

Although it is fast emerging as a dynamic destination for entrepreneurship, ***India is nowhere close to being Asia's Silicon Valley****. Government support, changes in the education system, and a more vibrant network of angel investors and mentors can help the country get there. [680]*

11.1. NSI Component 1: University and Higher Education System

I have discussed hundreds of issues related to Universities and National Laboratories in my series of 5 books on World Class University thus I would like to cover this topic briefly over here.

While there's lots of momentum in India, there are still **gaps in the ecosystem**. According to Paula Mariwala Executive Director Seedfund, speaking at a seminar on entrepreneurs and opportunities in India at Stanford University earlier this year, she said early stage investing is still far from mainstream, and there are several roadblocks – like lack of early adopters of products and services, access to technology and talent, and lack of a support system due to being a risk averse culture. On the latter point, it's widely known that Indian students are invariably encouraged to study engineering, medicine, law, and commerce, and then get 'safe' jobs rather than go into business. [679]

11.1.1. Old Scenario

There were virtually no start-up company activities at any academic institutions. A strong focus on publishing papers and lack of focus on patenting precluded the possibility of commercialization and spinning-off of companies based on research performed at academic institutions.

11.1.2. Current Scenario

- The academic institutes still predominantly have government funded R&D projects. However, in recent times institutes have made good efforts to participate in other R&D models. The IITs and IISc have taken a lead in various international bilateral R&D programmes…The National Institutes of Technology (NITs – formerly RECs) and state run colleges and universities have increased their participation in government funded projects. Private colleges and institutions have also now realized the value that R&D programmes bring. Some of them have developed pockets of excellence and activity in innovation.
- Another new development is the growth of start-ups from academic institutes. In the last few years, academia has shown increased collaboration with industry.
- Academic institutes have adopted better IP protection and sharing practices.
- They are also employing faculty with international as well as industrial exposure.
- The institutes now permit professors to get a share in industrial projects in terms of consulting fees.
- MNCs, large corporate, and PSUs have greatly increased their collaborations with premier institutes such as IITs.
- However there are still concerns of access to R&D facilities by small and medium size enterprises who are critical to the Indian economy and who need the technical help the most. [149]

11.2. NSI Component 2: National Laboratories

11.2.1. National Laboratories: Before 1991

The national laboratories were fully owned, funded and operated by the government. They were set up with the intention of helping the industry with their technology needs. They include CSIR, ICAR, DST, DBT laboratories as well as laboratories set up by various ministries in their focus areas. These laboratories had two primary models of R&D. [149]

- The first was government funded R&D based on proposals put up by scientists in these laboratories. Technologies developed in these programmes were available to industry for commercialization. **However, here too a focus on publications, which was one of the metrics required for progress in the scientific career, led to the technologies losing their novelty and proprietary character and hence their attraction to industry**. Moreover, technologies developed without the end-user involvement had many challenges and gaps when it came to actual practice. Many of the technologies developed in these laboratories remained **un-commercialized or under commercialized**. There was also **no start up or spin-off** activities related to these technologies. There were multiple reasons for this. These laboratories **did not have staff with business focus**, training or acumen. They primarily consisted of scientists. The employment rules were restrictive where the staff could not participate in ventures associated with their technologies. And lastly, there was no framework to give adequate support that is critical for tech start-ups to flourish. [149]
- The second model of R&D pursued by these laboratories was one of industry sponsored technology development projects. These were however few and far between. The laboratories did not and **still do not have ample business development staff** who proactively seek out industry clients. Such projects **only happened when** a particular company took the initiative, found a scientist who was willing and competent, and overcame the bureaucratic hurdles to set up a project. The industry usually got assistance at subsidized prices as all the manpower and overhead costs were not considered in costing the project. **Starting from the mid-90s, MNCs who were considering outsourcing R&D to India saw great potential in terms of equipment and scientific staff in these national laboratories. They were not averse to paying full costs for R&D. Hence the national laboratories which by now were under pressure to generate part of their funds on their own saw this as a lucrative avenue.** Some very large successful multi-year programmes were set up by MNCs with some of the premier national laboratories. [149]

Up until recently, there was **little collaboration between these laboratories**. The laboratories were focused on engineering or scientific disciplines and **not on application of technologies**. Hence they have many a times different national laboratories that independently pursued development of **similar applications** and technologies. [149]

11.2.2. National Laboratories: After 1991

- National laboratories continue to work with industry in **patches**. Their **predominant model still remains government funded R&D**. However, there are changes in the nature of projects.

- Industry is still **not an active participant** in these programmes, though unlike before, they participate, **albeit passively**, right from the beginning of the programme.
- Small and medium industries, today, have an even tougher time getting the attention or services of these laboratories and their scientists.
- Another development is the **increased emphasis on IP** and commercialization in the national laboratories.
- As with academia, available financial support and flexible employment rules permitting staff to take part in spin-offs, have created a **few instances of start-ups** that have emanated from the national laboratories.
- National laboratories still continue to be scientific discipline focused. This leaves individual laboratories **short in terms of multidisciplinary talent** that is required to solve complex technical problems of today. The organization and focus of these laboratories need to be re-evaluated in terms of today's needs.
- The **public sector (central and state) accounts for 70–80 percent of India's total R&D investment, equal to 0.8 percent of GDP**. The **bulk of that effort is mission-oriented R&D** in defense, space, and energy by the Department of Defense Research and Development (25 percent), Department of Space Research (17 percent), and Department of Atomic Energy (9 percent), respectively. **Less than 20 percent of public support for R&D is for civilian applications**: 8 percent goes to the 38 labs that make up the Council of Scientific and Industrial Research (CSIR), 4 percent to Indian Council of Agricultural Research (ICAR) institutions, 4 percent to the applied research programs of the Department of Science and Technology (DST), and 1 percent to the Indian Council of Medical Research (ICMR). The bulk of applied public research has been industrial research, which India has supported for more than 60 years through CSIR. With 38 laboratories and more than 5,000 researchers, **CSIR is one of the world's largest collections of industrially oriented public research labs**. It is India's main producer of scientific and technical publications and patents. Over the past 20 years it has gone through a major transformation—from producing technology for the domestic market to helping Indian industry become globally competitive and to being a global player itself. Many of the reforms it has made in its organization and management are relevant for other parts of the public R&D system. Relative to India's economic size and the international context, the **amount of public research is low**. The **effectiveness of public R&D spending is also low**. [149] [208]

Chapter 12: NSI Component: Industry

Professor Yash Pal, Former Chairman UGC said that "I think this business un-employability comes from the industry and this is mainly because ***industries are not research oriented****." [146]*

*"****Innovation is a key mantra to spur growth in Indian manufacturing sector****" – Mr. Ajay Shankar, Member Secretary, NMCC, GOI at CII MFG Conclave [201]*

More seriously, India's technological capability has been questioned on grounds of limited innovativeness…. However, ***university-industry interface*** *in India has been rather* ***ineffective*** *despite efforts in that direction over the last couple of decades. [397]*

From the innovation surveys, percentage of ***innovating firms*** *in India was* ***quite low*** *– FICCI Report 2012 [404]*

Another problem on the demand side is a ***lack of emphasis*** *on research and development (R&D) within companies. According to latest R&D statistics published by the Union department of science and technology, more than 60 percent of Indian industry's expenditure on R&D is concentrated in two sectors—pharmaceuticals and transportation. Given that the total R&D expenditure is also small. [147]*

As outlined in the beginning, ***R&D has never been a major concern for Indian industry****. Aided by* ***government policies that protected them from outside competition****, most* ***companies saw little need to spend money on research****. There was* ***not much demand*** *of the public R&D either.* ***Innovation was not a priority*** *and there was a general disinterestedness of the industry to develop products.* ***Re-engineering was the key concern*** *and with* ***not much commercial safeguards for innovative products****, incentives for innovation were not there in the industry. [140]*

As per White Paper (May 2013) by the Joint Committee of Industry and Government (JCIG) "Public investments meet nearly global benchmarks of 0.7% of GDP in India, ***private sector engagements into R&D are significantly lower*** *than those in developed and other emerging economies." [142]*

12.1. Industry: Before 1991

Before economic liberalization, India's dominant economic philosophy was one of **self-reliance**. The objective was to produce the country's requirements, to the extent possible, within the borders of the country. This self-reliance became an end in itself, leading to a very broad production base, but **insufficient attention to efficiency and productivity**...**R&D as was done by industry was concentrated on import substitution and the creation of local sources for inputs**…The small-scale sector was provided reservation in many sectors and implicitly encouraged to make imitative products through reverse engineering and improvisation… The **government dominated research and development activity**. Over 80% of the R&D done in India was financed by the government of India and conducted within government research laboratories…The government also created a network of forty laboratories under the aegis of the Council of Scientific & Industrial Research (CSIR) to do work of relevance to industry; however the links of these laboratories with the industrial sector remained limited and such technological capabilities as were created remained largely confined to the laboratories themselves… The economy was largely stuck in the historical "Hindu rate of growth" of about 3.5% and India had **fallen significantly behind countries such as Korea that at one time had comparable per capita incomes**. [396]

The challenge that faced Indian industry from the 1950s well into the 1980s was to become proficient in manufacturing. While most industries sourced production technology from outside the country, they had to make those technologies work in different climatic conditions, with raw materials of different quality and characteristics, and with a largely untrained workforce. So, the **focus of innovation was on adapting the processes** to locally available raw materials and intermediates, improving efficiencies through process improvements, and getting as close as possible to global productivity levels. [197]

R&D took place in the private industry in the form of incremental and reactive product and process improvements… Indian organizations always looked for the easier way of procuring ready and proven technology from companies abroad… Some of the small and medium companies were very successful in developing import substitutes and technologies of their own. **However, reliance on trade secret as a method of IP protection limited the commercial exploitation of some of these technologies**. Use of trade secrets created another issue. **R&D collaborations between industry and academia and national laboratories were relatively very less**. **This prevented a healthy R&D ecosystem from developing**. The private industry was further hindered by excessive duties, controlled pricing structure and restrictive license requirements imposed by the government. They were also resource constrained and had to operate in a controlled economy that was not driven by competition and market forces. **These reasons took away the motivation and drive for structured innovation which required serious investment. It drove them toward unstructured and homegrown techniques such as 'jugaad' and frugal engineering.** There are many unsung heroes in the industry who have built the foundation for new product and technology development using such methods. Indian industry became very efficient at copying, simplifying, adapting and in some cases improving upon western technologies at a **fraction of the original cost**. They, however, were unable to sufficiently exploit these successes due to the restrictive economic climate and an **un-favorable IP enforcement regime**. PSUs invested in setting up large R&D departments. However, similar to large private corporations, the provision of assured funding from their respective corporate offices made some of these departments disconnected and thereby less effective in addressing business technology needs. These companies continued to rely on foreign sources for providing technology to address their market needs. [149]

Prior to 1991, **innovation policy support in India was largely focused on funding R&D in the government-owned and operated R&D system, and on supporting academic research in government-funded institutions**. There was some financial support available for technology development and commercialization in public sector enterprises, but no such support was offered to private enterprises. The **only significant public fiscal support for private sector innovation** was through accelerated deductions of R&D expenditure from income calculations used for the computation of taxable income. However, the government did support one kind of low-cost innovation explicitly; by excluding product patents on drugs from the intellectual property rights regime, the government encouraged the creation of an indigenous drug industry with advanced capabilities in developing low-cost drug development processes. [399]

12.2. Industry: After 1991

When the Indian economy opened up in 1991, many Indian companies still had a lot of catching up to do. Even Tata Steel, which became a major player in the global steel market after it acquired Britain's Corus, had to **struggle hard to reach global productivity levels** and remain competitive. [197]

Dr. Biswajit Dhar, Director General RIS (an autonomous organization under the Ministry of External Affairs Government of India for policy research on international economic issues) and team members in their research discussion paper (**2014**) stated that "India's has undoubtedly attained the status of an emerging economy in the recent decades and continues to have a unique position among developing countries for its elaborate infrastructure of scientific research. However, as the 12th Five Year Plan document rightly points out, **since 1985 other emerging Asian economies invested heavily in R&D, significantly blunting India's edge in the S&T sector**. The government currently accounts for nearly 70 per cent of total R&D expenditure in India. According to India S&T Report, **six industries (pharmaceuticals, automotive, electrical, electronics, chemicals and defense) account for about two thirds of the total industrial R&D**. The pharmaceutical industry alone accounts for about 20 per cent of the total R&D expenditures…**More seriously, India's technological capability has been questioned on grounds of limited innovativeness**. There is growing discomfort and desperation around slow corrective actions, **deficient innovation paradigms** and laggard transformational changes, despite all old and new S&T policy initiatives… **Foundation of a sound innovation system rests on appropriate coordination between the public and the private sector**. However, **university-industry interface in India has been rather ineffective** despite efforts in that direction over the last couple of decades. Although some of the premier universities and research institutions enjoy international repute, world rankings based on quality and impact of knowledge creation remains short of significance. The larger S&T set up including higher education suffers from chronic problems of heterogeneity both in terms of quality and infrastructure. It is commonly held that Indian industry is myopic and risk averse and is often skeptical of collaborations with academic institutions. On the other hand, academic scientists are criticized for having failed to understand the commercial and technical needs of the industry. This is also linked to **India's inability so far to nurture learning and innovation networks with participation from both the public and private sectors**. Policy initiatives, however focused and well-intended, have **failed to forge synergies and coordination in this direction**" [397]

The Indian industry in recent years sees **applied R&D as an important** way to remain competitive in the future. There is an **increased awareness of IP** and the need to create and protect it. The industry has been investing increasingly in R&D. Indian corporations have started setting up large multi-disciplinary R&D centers. Medium scale industries are also making investments into R&D by setting up internal R&D teams and also engaging in collaborative projects with universities and national laboratories. Significant government tax incentives have encouraged industry in making some of these investments. However, realizing business value from such investments is still of concern to the industry. [149]

Since liberalization, Indian indigenous R&D spending at the enterprise level has grown significantly. In 1991, indigenous enterprise R&D spending as a share of sales was less than 0.1 percent. By 2004 that share was more than **0.5 percent**. Although this was a significant increase in less than 15 years, it remains low by international standards. Most indigenous Indian companies are funding little R&D on their own. Only three Indian companies—Ranbaxy and Dr. Reddy's Lab in pharmaceuticals and Tata Motors—are among the world's top 1,250 companies when it comes to R&D investment. India's pharmaceutical industry has developed world-class capability and become a major innovator. India's three top pharmaceutical firms (Dr. Reddy's, Sun Pharmaceuticals, and Ranbaxy) **invested 12–18 percent of sales in R&D in fiscal 2006**. These levels are comparable to those of some of the world's leading pharmaceutical firms, such as Pfizer (14.6 percent) and GlaxoSmithKline (14.0 percent). [208]

Before liberalization, the Government of India's involvement in support for R&D and technological innovation was largely through the direct funding of government research laboratories and establishments. While R&D in some public sector industrial enterprises received budgetary support, **there was no direct funding of R&D in the private sector**. Today, however, the Government of India has a multitude of schemes to support research and development in the country… Today, government gives Fiscal incentives for R&D; include tax breaks for R&D expenditure and exemption from excise duty for products developed indigenously for which international patents have been obtained. [396]

Table 2 Major Government-supported Programmes to Promote R&D in Industry

	Name of the Scheme/Programme	Key Features & Achievements	Nodal Agency
1.	Programme Aimed at Technological Self Reliance (PATSER)	Aimed at promoting industry's efforts in development and demonstration of indigenous technologies and absorption of imported technologies. Till November 2000, 113 projects of industrial units in both the private and public sectors had been supported with the total project cost of Rs. 1.5 billion of which the government's share was Rs. 450 million.	Department of Scientific & Industrial Research (DSIR), Govt. of India
2.	Home Grown Technologies Programme (HGT)	Aimed at promoting commercialization of indigenous technology. Attempts to catalyze R&D efforts by strengthening linkages between research institutions and industry with partial financial support. Launched in 1992. More than 50 projects funded already.	Technology Information Forecasting and Assess-ment Council (TIFAC), Govt. of India
3.	Technopreneur Promotion Programme (TePP)	Aimed at helping individual innovators to become technology-based entrepreneurs by providing financial support for the conversion of original ideas into working models and prototypes. Launched in 1998-99.	DSIR & Department of Science & Technology (DST)
4.	Technology Development Board (TDB)	The Technology Development Board (set up in 1996) uses money collected by the Government through a cess on import of technologies to invest (through equity or debt) in industrial concerns or other agencies to promote development and commercial applications of indigenous technology or adapt imported technology.	TDB

Source: *Research and Development in Industry: An Overview*. Department of Scientific & Industrial Research, Government of India, November 2000.

Table: 12.1: Government supported programmes to promote R&D in Industry [396]

Post-1991, the most significant development in the industrial sector has been the significant growth of the Indian **software services industry** that today accounts for 2% of gross domestic product and 15% of exports. In the **two-wheeler and pharmaceutical industries**, regulatory changes, demand conditions, competitive forces and entrepreneurial initiative have resulted in the development of innovative capabilities as reflected in a number of successful products…While in the past the **publicly-funded R&D infrastructure** such as the laboratories of the Council of Scientific and Industrial Research tended to be isolated entities with poor links with industry, the **last decade** has seen many of these laboratories **become much more commercially-oriented and direct their efforts towards international quality R&D**. This is reflected in the increasing number of US patents and growing external earnings of these laboratories…**NCL succeeded in transforming itself into a global R&D platform**, both licensing technologies and undertaking contract research for multinational corporations. [396]

Small scale industry still innovates on its own, in an ad-hoc manner, as and when resources permit. Government is setting up industry specific clusters to help small and medium industries in product development. These clusters have had mixed results when it comes to being successful in helping these industries. [149]

As part of the government's initiative to double the national R&D spend as a proportion of the country's GDP, PSUs now have a mandate to spend a percentage of their earnings on R&D. They are beginning to realize that being collaborative can help innovate in a competitive manner. However, their purchase and contracting systems currently limits them to IITs and government institutions in setting up R&D projects. They are working on setting up transparent ways to work with Indian and global private R&D laboratories. One such example is the R&D empanelment process initiated by Bharat heavy Electricals Ltd. (BHEL). This process has now been taken up by other PSUs such as Vizag Steel to help integrate them and tap into the global R&D ecosystem. [149]

Fig. 12.1: Presentation by Secretary, DST, Government of India: Industrial Research Paradigm of India - 2012 [220]

Technology start-ups are a recent development. There is increasing support for entrepreneurs with good technology ideas and products. The government provides good schemes, both grants as well as soft loans, for start-ups at various stages. International foundations also provide ideation, scale up and commercialization grants to start-ups for technologies which are at different maturity levels. **Recently technology incubators have come up in cities such as Bangalore, Hyderabad, Pune and Delhi.** These incubators, both private and government, provide equipped facilities and advisory support to technology startups. There is also a strong angel investor network in the country, which is actively supporting these start-ups. [149]

Report (2013) of Deloitte & Confederation of Indian Industry (CII) stated that “Currently in India, there is virtually no avenue to quickly solve industrial problems. Investment that government is making in R&D is not well-suited for industrial growth. Unfortunately, the R&D funding provided to high ranking universities and national laboratories **does not address** the needs of the rural innovators and SMEs. Approximately, **two-thirds of all R&D funding in India is spent on academia, government and national laboratories.** It is common to hear senior government officials repeatedly emphasize that industry should spend more on R&D. Generally speaking, **SMEs, who are fond of new ideas and innovation, are not rich enough to spend money on R&D**. **Large companies, on the other hand, that can spend on R&D, can always acquire new technologies through licensing or acquisition.** Moreover, even they cannot spend large sums of money to set up comprehensive laboratories that are required to solve today's complex problems." [400]

12.3. FICCI Report 2012: Comparison between South Korea, Thailand and India

In 2012, the FICCI has published a report on "Innovation readiness of Indian SMEs - Issues and challenges". From the innovation surveys, **percentage of innovating firms in India was quite low**. To illustrate this point, Indian situation was compared with that of a country being successful in technologically catching up **Thailand and Korea**. Comparison of innovation surveys, Thailand R&D/Innovation Survey 2001 and the Korean Innovation Survey 2002 with that of India showed the differences in terms of innovative capabilities of these three countries.

- India lag far behind the companies in Korea in respect to innovation and R&D activities. It strikes that a relatively high share of companies in India carry out solely product innovations, while this is quite rare in Thailand. This could be an indication that Indian companies are at the stage where they rather use their resources to improve product than the production process itself. At the same time very few companies in Thailand do product as well as process innovations, which is very common in Korea. This reflects **more mature innovation behavior of Korean companies** which improve in a systemic manner.
- Size of the company had a much greater influence on the capability of the firm towards investing in the activities pertaining to innovation. **Large companies are more likely to be innovative than SMEs**. It was witnessed that like in case of Thailand, most **Indian firms had grown without deepening their technological capabilities in the long run, and their technological learning has been very slow and passive**. Only a small minority of large subsidiaries of Transnational Corporations (TNCs), large domestic firms and SMEs have capability in R&D, while the majorities are still struggling with increasing their design and engineering capability.
- The slow technological capability development of Indian firms is quite different from those of Japan, Korea and Taiwan. Firms in these countries moved rather rapidly from mere imitators to innovators. As early as 1960s, Japanese firms advanced technologically to the world-class level. They became more innovative, invested heavily in R&D and relied less on importation of foreign technologies. [404]

12.4. India at Early Innovation Stage: Low Industrial R&D Investment

Another problem on the demand side is a **lack of emphasis on research and development (R&D) within companies**. According to latest R&D statistics published by the Union department of science and technology, more than 60 percent of Indian industry's expenditure on R&D is concentrated **in two sectors**— pharmaceuticals and transportation. **Given that the total R&D expenditure is also small**. [147]

It was also found that majority of R&D activities were carried out in the institutional sector and the industrial sector accounted for a small share of national R&D. This inadequate share of industrial R&D is a major handicap of Indian R&D system. In the current global scenario, gearing up of industrial R&D is essential for a developing country like India to expedite the process of development.

Nearly 80% of total industrial R&D expenditure is contributed by the private sector. In terms of number of units also, the private sector outweighs the public sector. Moreover, the average growth of R&D expenditure in the private sector is nearly three times higher than that in the public sector in post-liberalisation period. This implies that, by realizing the vital role of R&D, industrial units in the private sector have augmented their R&D efforts while their public counterparts failed to devote sufficient attention to R&D activities.

Fig. 12.2: Industrial R&D share in National R&D Funding [139]

A sharp distinction can be observed between **developed and developing** economies in terms of the intensity of investment in R&D and also in the major sources from which the investments are emerging. **Almost 70-80% of investments in R&D in developed economies are accounted for by its industries** whereas in developing countries the government accounts for this proportion of investment. Protectionist barriers (fiscal and non-fiscal), was one of the reasons for Indian firms not having the required push to invest in R&D. However, this was not the only factor. Indian firms operated on a small capital and were miniscule entities in comparison to global firms (MNCs). There were many regulatory barriers, rules and regulations, government controls that also acted as an impediment for Indian firms to expand. They directly or indirectly affected firms focusing attention in R&D… As outlined in the beginning, **R&D has never been a major concern for Indian industry**. Aided by **government policies that protected them from outside competition**, **most companies saw little need to spend money on research**. There was not much demand of the public R&D either. **Innovation was not a priority** and there was a general disinterestedness of the industry to develop products. **Re-engineering was the key concern** and with not much commercial safeguards for innovative products, **incentives for innovation were not there in the industry**. [140]

Indian companies have been loath to allocate more money to R&D. At present, they spend 0.6% on research compared with 3% in the West. Technology companies in the U.S. usually spend 5-6% on R&D and the number rises to 15% for pharma companies. [507]

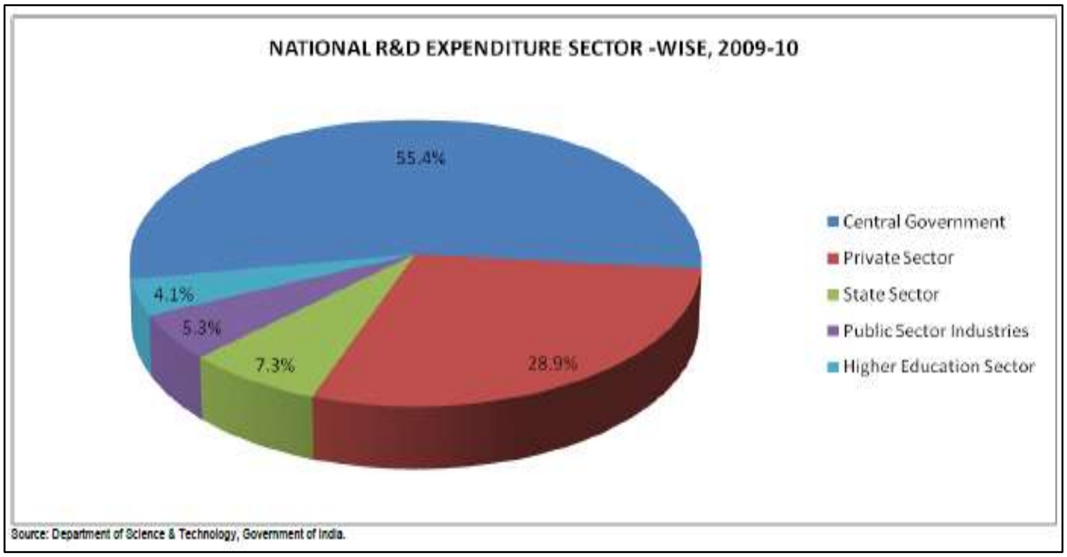


Fig. 12.3: National R&D expenditure sector-wise 2009-10 [143]

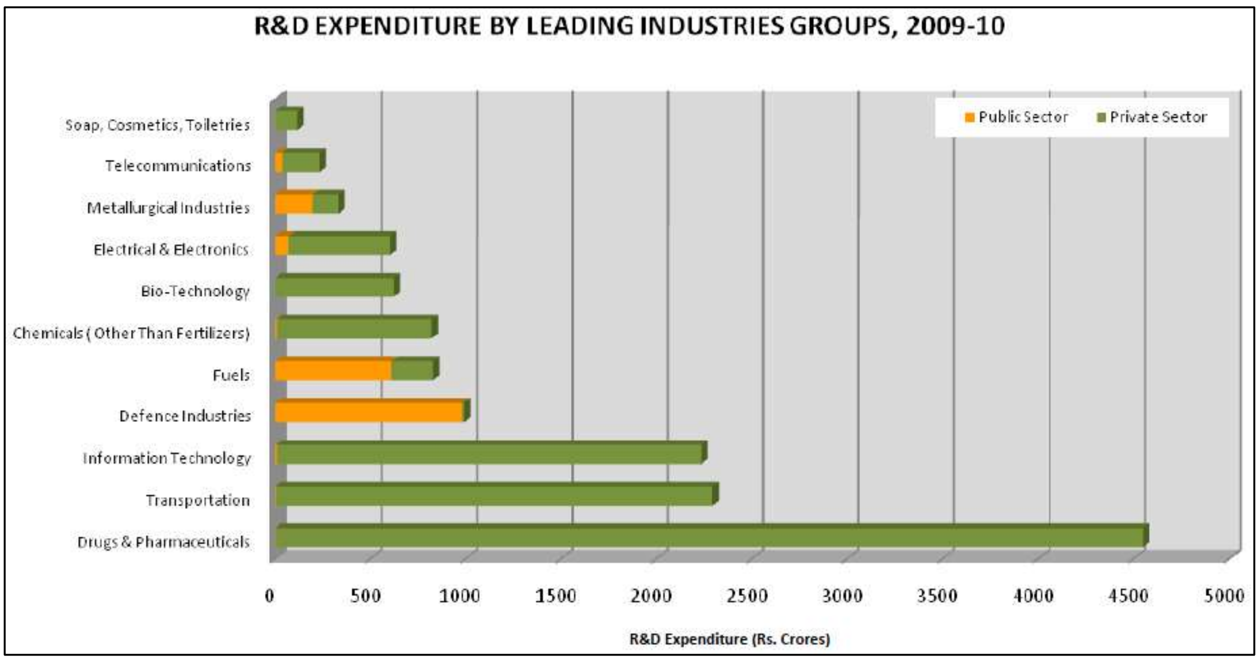


Fig. 12.4: R&D Expenditure by leading industries groups in 2009-10 [143]

Dr. Rishikesha Krishnan Director, IIM Indore explained the reasons behind the **slide in innovation ranking**. He said that "The R&D issue is more "tricky". India's R&D intensity has remained stubbornly range-bound between 0.9% and 1% for the last two decades. We pride ourselves on our ability to make do with less as exemplified by the achievements of the Space programme in the public sector, and that of automotive and pharmaceutical companies in the private sector. Yet, our adverse trade balance and poor standing in high technology industries (except for a small number of honorable exceptions) show that we have been **unable to develop the sophisticated technological capabilities needed to hold our own in global markets**. There is a **"chicken**

and egg" problem here – **some firms don't invest in R&D** because they don't have the right people to do R&D. And, in those companies where they do have the right people, the top management does not have the confidence to put enough resources behind the team. **Either way, firms fail to develop a sound R&D and innovation capability.** Given these problems, it is not surprising that India lags on knowledge and technology output as well." [243]

The World Bank Report (2007) stated that, Private enterprises need to increase R&D spending. Aggregate domestic R&D spending has never exceeded 1 percent of GDP, and 75–80 percent comes from the public sector. Domestic R&D spending is dominated by the public sector. India is still at a **typical early innovation stage** with regard to the distribution of domestic R&D efforts: about 75–80 percent of domestic R&D is conducted by the public sector, 20–25 percent by private enterprises, and just 3 percent by universities. In contrast, average R&D expenditures in OECD countries are 69 percent by enterprises, 18 percent by universities, 10 percent by government R&D labs, and 3 percent by private nonprofit institutions (OECD 2005). **In China, more than 65 percent of expenditures are undertaken by enterprises.** [208]

India was the **eight-largest country in terms of R&D investments in 2013**, with investments in the sector likely to increase to **US$ 44 Billion in 2014** from US$ 40 billion in 2012. The country's share of global R&D spending rose to 2.7 per cent in 2013 from 2.6 per cent in the previous year. The number of multinational corporation (MNC) R&D centres in India has increased at a compound annual growth rate (CAGR) of 14.4 per cent to **1,031** during the first half of 2013. [141]

- The Indian government has plans to involve the private sector in R&D, specifically for sectors such as vaccines, drugs and pharmaceuticals, and solar energy, among others.
- The Centre has contributed US$ 1.1 billion public–private partnership fund to support R&D in the country.
- The government also provides 200 per cent deduction for capital and revenue expenditure of manufacturing companies with in-house R&D.
- Income tax exemption of 125–175 per cent is also provided on donations made to colleges, universities and other scientific associations. [141]

In a sign that high-skilled Indian talent remains much in demand, as many as 25 more global companies have established R&D centres in India since the beginning of 2012. This takes the total number of MNC R&D centres in India to **about 1,031**.These MNC captive centres in India, combined with Indian providers of engineering R&D outsourcing, account for about **23% of the overall global engineering R&D outsourcing market**. This makes India by far the largest provider of such outsourcing services. [138]

On **May 2013**, the Joint Committee of Industry and Government (JCIG) published a white paper namely "Stimulation of Investment of Private Sector into Research and Development in India". In this white paper the committee stated that "Public investments meet nearly global benchmarks of 0.7% of GDP in India, **private sector engagements into R&D are significantly lower than those in developed and other emerging economies.**" [142]

Speaking on the occasion of releasing of this white paper, former Union Science & Technology and Earth Sciences Minister Shri Jaipal Reddy said **business enterprises are one of the**

main source of innovation. They play a significant role in funding and **performing R&D in most countries** and, more than ever, **governments seek to increase business investment in R&D and innovation**. Global competition has led countries to seek to **boost the innovative capacity** of the business sector. The minister said Government of India has laid high emphasis on attracting investment of private sector into R&D to match public investments (that is **1% of GDP each by Government and Industry**) before the end of 12th Five year plan. The minister referred Prime Ministers' appeal to the Private Sector to invest into R&D and match the public investments into R&D in this regard. He said **Science Technology and Innovation Policy 2013** enunciated by the Prime Minister during the Indian Science Congress this year also **gives emphasis on attracting private sector investment in R&D**. The minister further called upon the private sector to work together with public sector in **PPP mode** for the public good and happiness of the people of India. He said size of the 12th Plan for S&T sector has been estimated with a public investment of Rs. 120,430 crores. Given the current levels of investment of the private sector, an approximately **8 fold increase** in the engagement of the private sector into R&D would become necessary. This is an ambitious goal for both the Government and private entrepreneurs. The Joint Committee has made six key recommendations for implementation by the Government and Industry. These recommendations are

1. Redefining private sector R&D investment as per global norms
2. Mandatory disclosure of R&D investment by private sector
3. Rationalization of heads of R&D investment for direct and indirect incentives
4. Valuing and incentivizing IPR assets
5. Building technology depth of industry through PPP in national priority areas
6. Incentivization of commercialization of R&D. [148]

Shri Reddy said he sincerely feel that the initiatives on private sector engagement in R&D need scale up to a great extent if India were **to achieve the goal of 2% of GDP expenditure on R&D** and taking a leadership role in Science and Technology… This has been done to fulfil India's aspiration to emerge as one of the top five knowledge powers in the world, private sector's investments into Research & Development need to increase from its **current 0.3% of GDP** that is significantly lower than those in developed and other emerging economies. [148]

Research and development (R&D) spend in India has grown steadily to approximately $40 billion, representing around **0.9 per cent** of gross domestic product (GDP). This is still short of the Indian government's target of 2 per cent of GDP that was set in 2010 and reaffirmed in 2012. R&D spend is an indicator of competitiveness of a country's economy and many countries have set a target of investing one per cent of their GDP on R&D. Some developed countries have set their targets at three per cent of GDP. The USA, the UK, Australia, China, Japan, New Zealand, the Republic of Korea, the Russian Federation and Singapore have spent more than one per cent (in the range of **one to four per cent**) of their respective GDP on R&D. [163]

Their sheer size and growth potential — particularly India's — mean that China and India will be at the core of the Asian powerhouse over the coming decades. Over the past 20 years, the two countries have already more than tripled their share of the global economy. Adjusted for purchasing power parity (PPP), the Indian economy is now roughly the size of Japan's. In PPP terms, China's economy is likely to top that of the United States in the next year or two. The **Goldman Sachs** estimate suggests that India's economy will surpass the US economy by 2043. For long the world's second largest in population, the dynamics of India's population growth will push it ahead of China's in less than two decades. Despite this, **India will likely remain a lower-income country well into the century**, lagging behind China and its BRICS counterparts unless it can throw off the shackles of outdated development strategies and a culture of bureaucratic inertia — satisfied with benchmarking itself to standards that don't measure up internationally. [159]

Too often, however, innovation is conflated with levels of spending. Needed, instead, is a dynamic ecosystem for R&D and innovation with several crucial ingredients: financial investment of course, but also human, physical and natural capital, knowledge acquisition and transmission, laws and regulations, and institutions. Why are they important and how do these interact? **India's record is not only poor on each count, but there is also no integrated approach that links R&D activities across different institutions with the aim of increasing competitiveness**. As Dr. Manmohan Singh, Prime Minister of India, recognized, the share of the private sector is very small. In industrialized countries, governments and universities account for at most 20-30 per cent of R&D investment. The rest comes from the private sector. **In India these ratios are reversed**. In other emerging economies, while government shares are significant (just over 50 per cent in Brazil; over 30 per cent from universities and research institutions in China), they are still much lower than India's and the shares are declining… More than a **quarter of R&D investment goes towards basic research, against 5 per cent in China and 17 per cent in the United States**. Thus, India, with one of the lowest R&D/GDP ratios, is also expending the resources in areas without a direct connection to industry. This is another consequence of low private sector involvement in research. [303]

12.5. Reasons for Low R&D Investments by Private Sectors

R Gopalakrishnan, Director, Tata Sons stated that "I see that Indian regulations require public companies to share their R&D expenses and report figures related to R&D capital investments and revenue expenditure. These are more from a technological innovation point of view. Factors such as **market research, which form a significant component of market-led-innovation, are not accounted**. Another important factor which needs attention is that most of the Indian companies still have a **big chunk of market (the rural India) to capture** and thus a major part of the revenues are spent to enhance existing supply-chain and customer attraction processes. Further, I see that despite having low researchers per million of population, India continues its robust growth through manufacturing and services sectors, and thus **low R&D investment can be viewed as a strength and not a weakness**." [410]

12.6. In Future: One of the Big Items on the Agenda of Corporate India Will Be Innovation

Indian business for the most part is about 30 years old. Before that they didn't need to be innovative. So innovation has only been on the agenda for the last 30 years. At some stage, the problem for most Indian companies was that demand was exploding and "how do I ramp up supply to meet that demand”. Now we are finally at a stage where corporate India will have (a) hard look and say “we have to become innovative”. This will require us to invest in R&D (research and development). Indian corporates’ investment in R&D is about 0.6% of their sales. In China, it is 1.2%. For the West, it is about 3-5%. We have to increase this if we have to go for innovation. It is not as if people in India are not innovative, but they haven’t been given the resource, structure or the process to become innovative. And we have to do that. Over the next 10-20 years, one of the big items on the agenda of corporate India will be innovation. [506]

Chapter 13: NSI Components: MNC R&D Centers

*Currently, India has about **83 per cent of the top 100 global R&D spenders** and **half of the top 500 global R&D spenders**. [407]*

*The world FDI inflows are about $1,500 billion a year, China is impressive at $120 billion a year, but India is not so, with a much lower **$25 billion** annually. [407]*

*From a wider perspective India needs to **reallocate its resources** (intellectual and financial) away **from outsourcing and into innovation**. India's intellectual talent is currently geared towards **innovation for others** – directly **through MNC's** captive centres and indirectly through the outsourcing to India of MNC research and development. This represents the single greatest limitation on India's future growth. Outsourcing has been characterized as "**Colonialism 2.0**" defined by an emphasis on the export of India's "raw materials rather than high value finished products". Domestic industries (both public and private) have massively underinvested in R&D. [31]*

13.1. R&D Internationalization

R&D internationalization is not a new phenomenon. It is an activity for resource exploitation and augmentation through various channels beyond the national boundary. It is a global search for talented human resources, conducive research environment and low cost for R&D activities. Firms have always been in the lookout for newer knowledge to enhance their competitive strength. It gives firms access to diversified resources. The ability of the firm to exploit and utilize this for **innovation benefit** is a firm specific characteristic of internationalization. The implications are global, national and at firm level… **Internationalization of R&D and innovation in the Indian context is the measure of FDI inflow and outflow in R&D as a percentage of total R&D investment in India.** MNCS, Indian firms, universities and the public research institutes together contribute to the process of internationalization. It is a measure of the nature and type of R&D activities undertaken by the MNCs in India and also the R&D activities of Indian firms outside India. **It is also a measure of the extent of Indian R&D and production system getting linked to the global R&D system, through MNCs R&D activities in India**. [406]

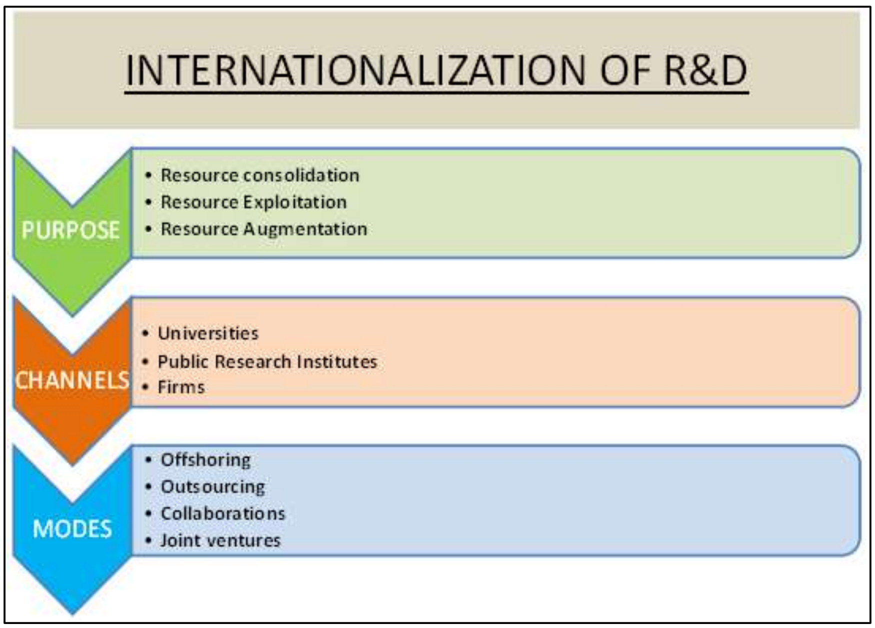


Fig. 13.1: MNC R&D is a part of Internationalization of R&D Process [406]

The number of multinational corporation (MNC) R&D centres in India has increased at a compound annual growth rate (CAGR) of 14.4 per cent to **1,031 during the first half of 2013**. [141]

13.2. Colonialism 2.0

R Gopalakrishnan, Director, Tata Sons stated that "Currently, India has about **83 per cent of the top 100 global R&D spenders** and **half of the top 500 global R&D spenders**. Patent registrations in the US from India have dramatically increased, albeit on a small base, from 94 in 2000 to 200 in 2010. As R. A. Mashelkar once observed, foreign companies are **using Indian brains to research their problems, develop patents for them, and then registering the patents in their own country**. Therefore, India can attract FDI on the strength of being a positive hub of innovation…. The 2014 report shows that global confidence in India was **ranked seven**, just behind Germany and just ahead of Australia and Singapore - does not seem bad… However, India was **number two in 2012** and **number five in 2013**, so India has also been slipping. Knowing the political and economic events in the country, perhaps this is no surprise… Considering that the world FDI inflows are about **$1,500 billion a year**, China is impressive at $120 billion a year, but India is not so, with a much lower **$25 billion** annually." [407] [408]

From a wider perspective India needs to reallocate its resources (intellectual and financial) away **from outsourcing and into innovation**. **India's intellectual talent is currently geared towards innovation for others – directly through MNC's captive centres and indirectly through the outsourcing to India of MNC research and development.** This represents the **single greatest limitation on India's future growth**. Outsourcing has been characterized as "**Colonialism 2.0**" defined by an emphasis on the export of India's "raw materials rather than high value finished products". Domestic industries (both public and private) have massively underinvested in R&D. [31]

Possible short-term negative spillovers include **diverting talent away from India-**specific needs and raising the cost of talent for indigenous firms. Although some MNC research may be focused on the needs of the domestic market, the bulk of it is likely for the MNCs' global operations. Thus, there could be a direct opportunity cost to India in the short term. In addition, the strong rise in demand for Indian scientists and engineers is leading to **rapidly rising salaries and strong competition for their talent**. This talent pool is not as large as is commonly thought, and salaries are rising very quickly. Thus, a secondary effect is that the rise in salaries induced by the increasing demand by the MNCs may be making it more expensive for the government, universities, and domestic firms to do R&D. Although large domestic firms may be able to compete, that may not be possible for smaller firms, public labs, and universities. As a result they could incur a cost and a net loss in the short term—except to the extent that they may have positive interactions and contract work from the growing research demand of the MNCs. [208]

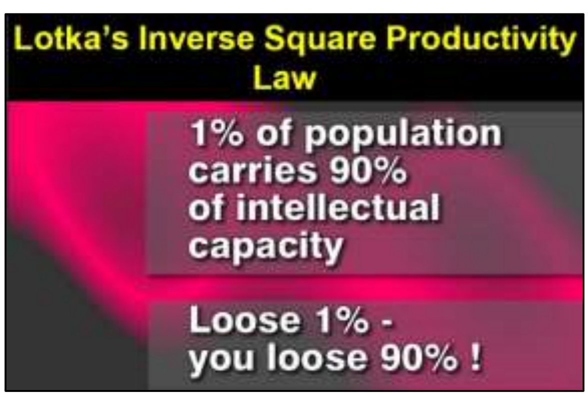


Fig. 13.2: MNC Invisible Brain Drain: Lotka's Inverse Square Productivity Law [206]

13.3. Patent Scenario

Multinational corporations accounted for **2609 of the 4888 patents (53 percent)** awarded by the US Patent and Trademark Office (USPTO) to inventors based in India between 1995 and 2008. Representing their dominance of patenting activity in the fields of electrical engineering and information technology, they accounted for **1789 of the 1961 patents (91 percent)** awarded by the USPTO to Indian inventors in these domains during the same period…One limitation of the MNC R&D centres in India has been their **poor links to the broader Indian innovation system**. This has meant that the **spillover from these centres to the broader economy has been limited**. [399]

TABLE 1: US PATENTS GRANTED TO INDIAN INVENTORS OR INDIAN ASSIGNEES

COMPILED BY SWARNA KUMAR VALLABHANENI FROM WWW.USPTO.GOV

SOURCE: KRISHNAN, RISHIKESHA T. (2010). *FROM JUGAAD TO SYSTEMATIC INNOVATION: THE CHALLENGE FOR INDIA*. BANGALORE: UTPRERAKA FOUNDATION.

	1976-1994					1995—2008				
Field	MNC	Indian Corp.	Indian Res./ Acad.	Others	Total	MNC	Indian Corp.	Indian Res./ Acad.	Others	Total
Chem	158	19	40	69	286	432	651	962	203	2248
EE/IT	28	1	1	11	41	1789	66	44	62	1961
Instr.	13	2	1	22	38	255	23	54	55	387
Mech.	22	8	2	24	56	101	46	23	46	216
Other	2	3	1	8	14	23	6	3	17	49
Total	**223**	**33**	**45**	**134**	**435**	**2600**	**792**	**1086**	**383**	**4861**

Fig. 13.3: US Patents Granted to Indian Inventors or Indian agencies [399]

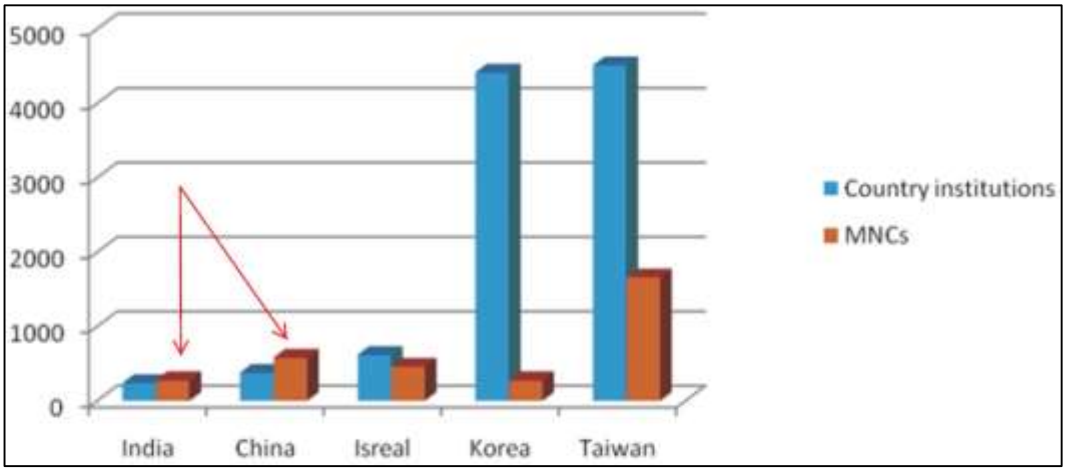


Fig. 13.4: US patents granted to inventions of various countries (Source: R&D India, Newsletter October 2006, DSIR, New Delhi) [140]

Observe above figures, In India, the patent contribution of MNC is greater than Indian organizations.

13.4. MNC R&D Centers: Before 1991

India is a research and development hub to several global companies. Multinational companies have been setting up their R&D units here since 1985 and continue to show interest in India for their research and product development needs At the corporate level, the trend of R&D off-shoring to India started way back in 1984 when Texas Instruments had set up its first India R&D centre in Bangalore. Since then a large number of foreign players have forayed into the country and started their R&D activities in India. Companies that have shown strong preference to establish their R&D and manufacturing centers in India have repeatedly mentioned the top three reasons to enter India

- As large burgeoning market for virtually all types of products and favorable demographics,
- Access to young science and engineering talent pool, and
- Opportunity to reduce cost of doing R&D.

Other factors such as

- Fluency in English language,
- India's strengthening intellectual property regime, and a
- Strong judicial framework

are always present in the background. In the past, the mantle of R&D in India was **borne primarily by academic institutions, and the national, defense and space laboratories**. The models were simple, but largely with a few notable exceptions, **focused on creating scientific knowledge rather than helping the industry and the economy**. [149]

MNCs with manufacturing set-ups in India also followed a similar pattern. Platform technologies were developed in their parent nation and brought to India. The local R&D team assisted in ensuring that the products were produced to the quality required. Further they also undertook productivity improvement projects to reduce manufacturing costs. Starting in the late 90s, many MNCs came to India to set up R&D outsourcing centers. **The primary model was to perform R&D in India for their global operations thus earning great cost leverage**. This model became a great success and was replicated by many US and European companies. [149]

13.5. MNC R&D Centers: After 1991

The top 1000 R&D spenders (multinational companies) had increased their spending from $549 billion in 2008-09 to $582 billion in 2010-11. **These multinational companies (MNCs) play an important role in economy and R&D activities of host countries, particularly the developing countries.** At present, more than **one third of the top 1000 global spenders (MNCs) have set up R&D centers in India**. Its share in global annual R&D spending is 2.8 % in FY 2011. The R&D expenditure through foreign direct investments (FDI) has increased in India from INR 286 crores in 2002-03 to INR 2883 crores in 2009-10. The share of foreign companies in overall Indian R&D has risen to about 20 % by 2009-103. According to a Zinnov report4, India currently hosts **1031 MNC R&D centers** till the end of 2013, growing at 4 % a year, with an **employment base of 244000** growing at 11 % per year…the total number of FDIs in R&D in India was 964 from 706 MNCs originating from 23 countries and they together brought $29 billion as FDI in R&D in India during 2003-09. Country-wise number of FDI investments in R&D indicates that USA had largest number of investments (591), followed by UK (51), Germany (49), France (31), Japan (27), Switzerland (21) and 17 other countries (127). In terms of sectoral share of total FDI in R&D, the largest share (50.36 %) was in IT & Software, followed by aerospace (12.52 %), pharmaceuticals & biotechnology (9.72 %), automobiles (9.27 %), machinery & equipments (3.01 %), services (2.62 %), electronic components (2.56 %), chemicals (1.25 %), etc. These 706 MNCs created 247000 jobs through R&D investments in India over the past decade and also obtained 1166 patents during 2003-09… The presence of these multinational companies in India is slowly leading to its rapid integration into the global research system. India is fast emerging as a major destination for high-end R&D projects for MNCs across the globe. India is being benefited from these foreign R&D centers in terms of employment, as sizable number of PhDs, Master and Bachelor degree holders in science and engineering, and technicians, etc., are working on future technologies, working with sophisticated equipment/machinery and getting opportunities for specialized education and training abroad. Indian R&D organizations, universities and industry are also gaining by working with these foreign R&D centers through contract research, collaborative research, training programmes and courses being conducted by some of them. Many of these foreign R&D centers have established collaborated linkages with institutes of national importance, government departments, national research laboratories, engineering colleges, etc8. The research and technology output of foreign R&D centers in India comes both in the form of patents and research papers. [426]

Fig. 13.5: World R&D expenditure and 700 Largest R&D Spending Firms [425]

Murali Subramanian, Group vice-president, **Oracle** said that "**Three distinct factors are behind India's growing acceptance as the ideal R&D base**. Talent pool, domain expertise and leadership. Finding the right talent is a critical success factor for an R&D organization and India scores high with ample availability of strong technical as well as managerial talent. Furthermore, this talent pool has also built strong domain expertise over the last 20-25 years from its experience of dealing with global customers. **The combination of technical, managerial and domain expertise helps companies establish and run a strong R&D organization in India…The third dimension is leadership.** For India today offers a very powerful pool of middle and senior-level management with a global experience. All these factors are very conducive for a company to establish an R&D Centre in India… Starting in May 1994, with a few employees operating from two rented rooms in Bangalore, Oracle today has a full-fledged R&D organization in India with the presence of large research, development and expertise Centre's across four major cities—Bangalore, Hyderabad, Noida and Thiruvananthapuram. Almost every product in the Oracle portfolio has dedicated development teams in India. Each one of these development teams cover the full software development life cycle by having product management, engineering, quality assurance, infrastructure and technical writing functions in India. We have definitely grown from strength to strength over the last 15-20 years; today we hire some of the best talent from top institutions of the country and are a preferred employer for the best R&D minds of India…In fact, India is the ideal place because you can find the ideal mix of top talent and leadership at a scale that you want to drive R&D." [405]

Hari Vasudev, Vice-president and Head, **Yahoo! India R&D** said that "India has strengths that promise to make it a **leading Centre of technological innovation of the 21st century** and Yahoo! was one of the first few companies to realize this potential, stresses. Given the strategic location advantage, optimized cost structure, access to a large talent pool and a strong ecosystem, India is clearly burgeoning with cutting edge talent that makes it a **dream R&D destination**. And this is only the tip of the iceberg, we are going to see a lot of innovations going out to developed markets from India". Yahoo! set up a full-fledged R&D Centre in Bangalore in 2002. Since then, Yahoo! has made significant investments both in terms of technology and talent, thus making the Bangalore facility **Yahoo!'s second-largest R&D Centre in the world**. Over the years, the Centre has leapt up the value chain, transforming itself from an engineering Centre to a customer-centric innovation hub that's making a strategic impact globally. Yahoo! India R&D has delivered end-to-end development of over 20 products for global and emerging markets of Yahoo!. One of the solid proof of innovations happening at the Centre is that idea submissions for patent review at the Centre have seen an average rise of 40% in last three years. [405]

Successful R&D only happens where talent is available—India's population is today among the top three scientific manpower of the world and globally the experience of last 20-25 years has proven that **right talent must be tapped closer to where it is found**. It is therefore strategically critical for global organizations to leverage this talent pool—simply because they need to hire the **top talent that can drive ongoing innovation**. [405]

R&D centers of MNCs in India have "moved up" the value chain by starting to support its India and Asia market needs. They see value in the India innovation paradigm which helps them develop rugged low cost products that are applicable to large parts of the world. Government should recognize this and support them in such efforts. MNCs with their considerable and proven expertise in running R&D programmes can help set the standards in India for result oriented and timely applied R&D. [149]

As per World Bank Report (2007)

- However, between 1998 and 2003, multinational corporations spent $1.3 billion on R&D in India—showing that its valuable assets could be exploited more effectively
- Since the Indian economy was opened up in 1991, the private sector has invested the most in research and development (R&D) in the sectors most open to competition. In 2004, enterprise R&D was more than **seven times higher** than in 1991.
- Innovation is crucial for increasing growth and can also help reduce poverty.
- India stands to gain more from catching up to the global frontier of knowledge through **increased absorption than from trying to push out the frontier through creation**. An enormous amount of existing global knowledge is not yet fully used in India. A 2006 World Bank Enterprise Survey of roughly 2,300 manufacturing enterprises in 16 Indian states found that applying existing technology in new settings is more likely to be associated with increases in productivity **than are efforts to create new knowledge**. [208]
- MNCs have discovered that India is an excellent location for R&D. In several international surveys, investors have ranked India as their **preferred destination** for locating innovation centers. [208]

Foreign firms with R&D operations in India, in particular, are playing a key role in the growth of patenting activity in India**. USPTO patent grants received by leading MNC R&D centers in India have grown exponentially**, at a CAGR of 41 percent in the last five years to cross 3,800 patents in 2007-12… Although the US patenting trend is improving, the MNC R&D centers in India contribute just 2 percent to the global patent grants received by the company despite having a critical mass of local engineering talent. In addition, the average patent density (number of patents per 100 R&D employees) of global centers in China and Israel is 2-3 times more as compared to that in India. [161]

Some 40 MNC research & development centres in India have come together to fast-track the process by which software architects are created. The intent is to build a pool of 5,000 architects by 2016, a move that could catalyze the technology innovation environment in India. Among the companies involved are Honeywell, EMC, SAP, McAfee, eBay, Symantec, Alcatel-Lucent, Huawei, VMware and Zinnov Consulting. [200]

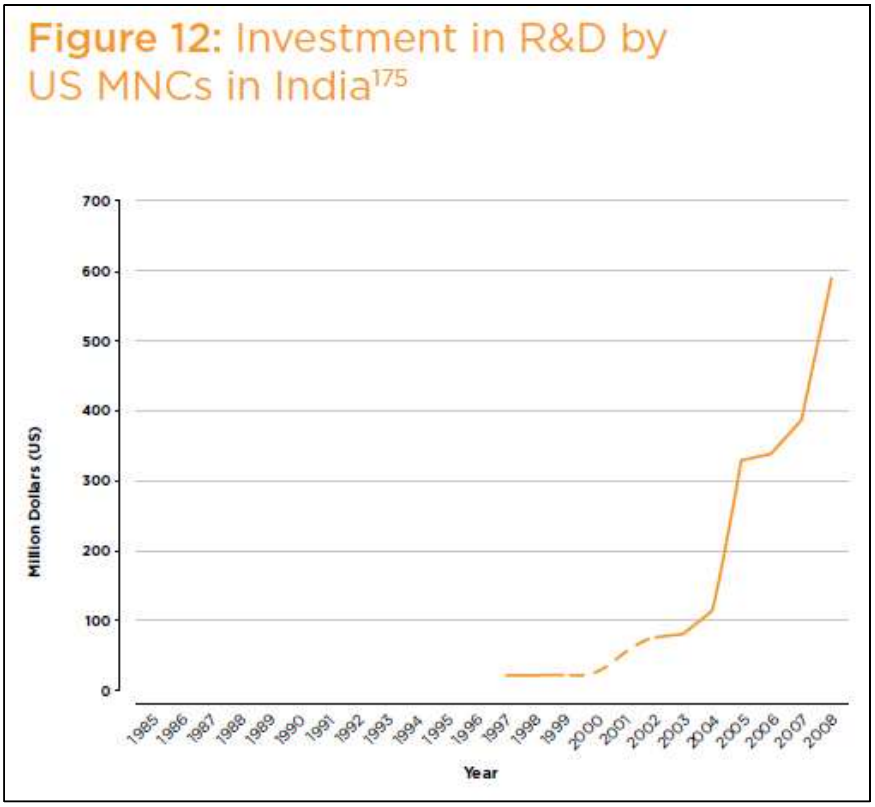


Fig. 13.6: R&D investment of US MNC in India [76]

The huge influx of foreign direct investment (FDI) in India's electronics and IT sectors has led to **a growing number of university-industry partnerships for undertaking R&D**. The Indian Institutes of Technologies (IITs), Indian Institutes of Science (IISc), and other specialty institutes are hubs for innovation fueled by investments from overseas IT companies. [208]

Technology-intensive multinational corporations have established numerous research centers in emerging economies, largely staffed with local talent. The first MNC R&D centers were primarily concerned with development of technology to adapt companies' global products to local needs and conditions. It became apparent that in a number of countries a significant pool of R&D talent existed which was **at a far lower cost than comparable workers in developed economies**, and that MNCs could **dramatically reduce their R&D costs and increase productivity by shifting some research functions** to emerging markets . The **9/11 attacks** led to a **tightening of U.S. immigration policy** and a number of MNCs which relied heavily on foreign-born researchers, accelerated the move offshore to **retain access to foreign talent**. More recently, MNC offshore R&D centers have been the source of some remarkable achievements, demonstrating that they are becoming integral to the R&D strategies of global technology leaders. [225]

Consulting estimates that as of March 2011, multinational corporations had **established over 1300 R&D centers** in the country, more than double the number that existed in 2003–04. [225]

As corporations cut or hold flat their R&D operations in the U.S., they are rapidly expanding their offshore design and engineering centers. This enables corporations to draw on strong local talent and adapt to fast-growing markets. As noted above, **in some cases, they are responding to foreign government pressure to transfer technology and know-how**. [225]

> For example, General Motors' first R&D lab outside the US established in India in 2003. Jack Welch of General Electric would seem to agree. When asked why they were setting up their largest R&D centre outside of America in Bangalore Welch said, "We get the highest intellectual capital per dollar here." GE now employs over 14,000 people in India. JFWTC has grown from a 275---employees to over 4,000 employees today. Dr. Sanjay Correa, GE MD of the John F. Welch Technology Centre says: "Drawing on India's unique multi–disciplinary skills – from mechanical and electrical engineering to polymer science and chemical engineering – the Centre incorporates the latest technology and e–engineering tools to facilitate real–time global interaction with GE's businesses, technology centers, customers and suppliers. "The JFWTC, inaugurated on Sept 17, 2000, is home to state–of–the–art laboratories working on research and development in the areas of mechanical engineering, electronic and electrical system technology, ceramics and metallurgy, catalysis and advanced chemistry, chemical engineering and process, polymer science and new synthetic materials, process modeling and simulation, power electronics and analysis technologies. The 545,000 square foot Centre has filed for more than 185 patents for research and development activities here in Bangalore and been granted 12 to date." In healthcare, General Electric are clear about why they believe India has an advantage over the West. R&D costs in India are lower but more importantly **development times are much shorter** – **what takes 18 months in the US can be done in 3 months in India**. This is largely due to the number of patients available for conducting medical research in India. [31]

India attracts more inbound R&D facilities from the largest foreign multinational firms than other prominent nations such as Japan, France, Canada, and Brazil. As of today, India attracts more R&D facilities from U.S. multinationals in the Fortune 500 than any other nation. [31]

Dr. Mashelkar believes that India can become the world's number one knowledge production centre by 2020. Emphasizing the inclusive innovation concept, Mashelkar sees India creating not just valuable private goods but also public goods that will help a growing population suffer less and live better. Dr. Mashelkar believes: "today's returnees to India are finding that the opportunity to do cutting---edge research has increased many fold compared to what it was before. The latest Intel chip and the latest GE aero engine are being designed in Bangalore, for example. The Indian automobile industry now is exporting indigenously designed and manufactured cars such as the Indica to European markets. The R&D programs of Indian drug and pharmaceutical industries now are trying to create new therapeutic molecules as opposed to just copying drug molecules made by others." As Geetha Vani Rayasam, a senior scientist at Ranbaxy Labs notes, "The day is not far off when India might be leading the way in drug discovery too." [31]

13.6. Singapore Approach

Singapore directed the industrial policies towards employment-creation, using favorable incentives to attract foreign direct investment and multi-national companies (MNCs) to increase productive capacity. Gradually, a vibrant manufacturing sector was formed and dominated the economy. Unlike other "Asian Miracles", **Singapore primarily relied upon MNCs to produce the knowledge spillovers** and technology transfers necessary to develop its national technological capability rather than indigenous R&D. [173]

I have discussed this issue in more details in part IV of this book.

13.7. Need Careful Analysis and Policy

The net effect of the rapid rise of MNC research centers in India is **complex and requires careful analysis**, though it is likely to be strongly positive over the longer term. It would be useful to conduct additional surveys to better understand the focus of the research by the MNCs and the career paths of the Indian scientists and engineers working for them. [208]

Chapter 14: NSI Component: Intellectual Property Rights (IPR)

*Intellectual Property Rights (IPRs) are **crucial for innovation**. It is the foundation of any knowledge-based economy. It is the **interface of - creations and rights**. [170]*

***Strong IP systems facilitate strong FDI**, thereby producing more jobs for the people, providing them better opportunities and pumping capital into the economy. [63]*

***Intellectual property** helped make possible the **conditions for innovation**, entrepreneurship and market-oriented economic growth that shaped the 20th Century. In the 21st Century, Intellectual Property Rights (**IPRs)** increasingly will define these conditions, and will **dictate the pace and direction of innovation, investment and economic growth around the world**. [164]*

*IP Protection **Stimulates** Innovation and Spurs Sustainable and Widespread Economic Growth by Providing **Incentives**. That Ensure a Sufficient Supply of New Inventions and Creations. IPRs **promote risky, uncertain and costly** investments. IP rights **create new markets because IPRs are tradeable and transferable**. [164] [169]*

*Report (2013) of Deloitte & Confederation of Indian Industry (CII) stated that "One of the several reasons that India has **lowest patent registration rates per million of population** (8 patents are filed by every 1 million people as opposed to 396 in China) is **lack of awareness** and the **cost-based mind-set**. The **thrust on innovation is inexistent in our education system** ab-initio and majority of the Small and Medium Enterprises (SMEs) are driven by cost-based value proposition... India has less than 300 functioning examiners across four Patent offices today, as compared to 8400 in the US. The **average time to issue an examination report is over 55 months** as compared to 20-25 months in majority of the other patent grating countries." [400]*

14.1. Intellectual Property Rights: Crucial for Innovation

Intellectual Property Rights (IPRs) are **crucial for innovation**. It is the foundation of any knowledge-based economy. It is the **interface of - creations and rights**. It pervades through all sectors of the economy and is increasingly becoming important for ensuring competitiveness of the enterprise. It is the original creation of human mind that has economic value and is protected by law. The extent to which countries **protect their Intellectual property** (IP) will determine how well they perform in the new economic environment. **Role of IPR lay in providing a legal right to the inventor to protect his/her creation as well as preventing others from illegally exploiting the creation and thus avoid re-invention of the wheel.** "Your ideas are your property and you have every right to benefit from it" - is the core ethos around which intellectual property rights have been formulated. These are the rights given to a person over the creation of his own mind. The chief purpose is to encourage inventiveness and research that leads to new ideas and the development of new technologies. [170]

The report of US Patent & Trademark Office (USPTO) state that "**The granting and protection of intellectual property rights is vital to promoting innovation and creativity** and is an essential element of our free-enterprise, market-based system. Patents, trademarks, and copyrights are the principal means used to establish ownership of inventions and creative ideas in their various forms, providing a legal foundation to generate tangible benefits from innovation for companies, workers, and consumers. Without this framework, the creators of intellectual property would tend to lose the economic fruits of their own work, thereby undermining the incentives to undertake the investments necessary to develop the IP in the first place. Moreover, without IP protection, the inventor who had invested time and money in developing the new product or service (sunk costs) would always be at a disadvantage to the new firm that could just copy and market the product without having to recoup any sunk costs or pay the higher salaries required by those with the creative talents and skills. As a result, the benefits associated with American ingenuity would tend to more easily flow outside of the United States." [244]

Report on Thomson Reuters Derwent World Patent Index 2013 (DWPI) stated that "Patents are a proxy for innovation. **Inventive ideas that are unprotected cannot be successfully commercialized**. Therefore, by looking at patent activity, one gets a **true picture of the innovative landscape**, regardless of how commercially successful an invention is. [403]

Intellectual property helped make possible the **conditions for innovation**, entrepreneurship and market-oriented economic growth that shaped the 20th Century. In the 21st Century, **Intellectual Property Rights (IPRs)** increasingly will define these conditions, and will dictate the pace and direction of innovation, investment and economic growth around the world. Today, more than ever before, innovation, enterprise and intellectual assets drive economic growth and increase standards of living. Innovation is instrumental in creating new jobs, providing higher incomes, offering investment opportunities, solving social problems, curing disease, safeguarding the environment, and protecting our security. To help achieve these objectives, governments must create appropriate incentives for continued growth in innovation and technology development and embrace sound policies for assuring broad social diffusion and access to key scientific and technological advances that enable us, as Newton first observed, "to stand on the shoulders of geniuses". A critical enabling tool increasingly is intellectual property protection. Intellectual property rights are essential for achieving many of today's challenges related to innovation and economic growth while providing the foundation on which tomorrow's societal needs can be met. Their vitality derives from the multiple roles they play. These include:

1. IP Protection stimulates innovation and spurs sustainable and widespread economic growth by providing incentives that ensure a sufficient supply of new inventions and creations
2. IPRs promote the disclosure of inventions and pioneering information, which stimulates innovation across and within industries
3. IPRs promote risky, uncertain and costly investments
4. IPRs empower consumer protection in a global economy
5. Effective competition policy depends on an appropriate IP regime
6. Securing the benefits of IP for the digital economy
7. IP rights create new markets because IPRs are tradeable and transferable
8. IP enables innovation in key economic growth sectors such as healthcare
9. IPRs play a crucial role at the intersection between science and innovation [164] [169]

14.2. IPR Tools to Protect Innovations

The various tools of IPR that are used to protect innovations are:

- **Copyright**: is concerned with protection of creative works that are musical, literary, artistic, lectures, plays, art reproductions, models, photographs, computer software, etc.
- **Patent**: pertains to pragmatic innovations and aims to protect inventions that are novel, non-obvious and useful.
- **Trademark**: is related to commercial symbols and concern to protect distinctive marks such as words/signs including personal names, letters, numerals, figurative elements (logos); devices; visually perceptible two or three dimensional signs/shapes or their combinations; audible signs (sound marks) e.g. the cry of an animal or laughing sound of a baby; olfactory marks (smell marks), use of certain fragrance.
- **Industrial Designs**: protects novel nonfunctional features of shape, configuration, pattern, ornamentation or composition of lines or colors, applied to any article either two or three dimensional or in both forms by any industrial process or means whether manual, mechanical or chemical, separate or combined which in the finished article appeal to and are judged solely by the eye.
- **Geographical Indications (GI)**: are defined as that aspect of industrial property, which refers to the country or to a place of origin of that product. Typically, such a name conveys an assurance of quality and distinctiveness of the product, which is essentially attributable to the fact of its origin in that defined geographical locality, region or country. For example: Basmati rice, Darjeeling tea, Kanchipuram Silk Saree, Alphanso Mango, Nagpur Orange, Kolhapuri Chappal, Bikaneri Bhujia, Agra Petha [170] [427]

Fig. 14.1: Presentation by Dr. R. A. Mashelkar: Categories of IPR [206]

Fig. 14.2: Presentation by Dr. R. A. Mashelkar, Director CSIR: IP Includes rights related to number of issues [206]

14.3. Advantage and Disadvantage of IP Driven Culture for India

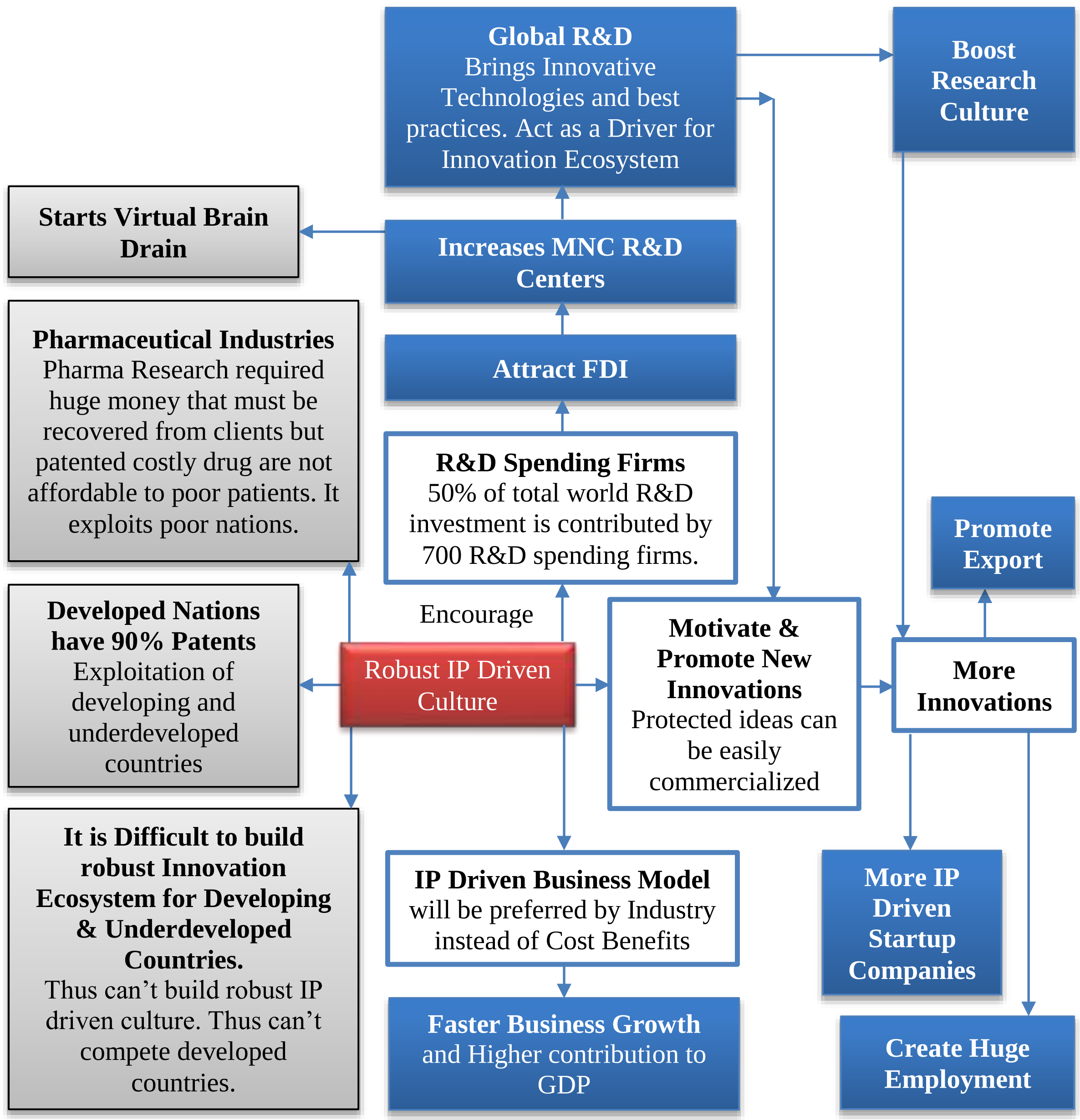


Fig. 14.3: Advantage and Disadvantage of IP Driven Culture

The gray color box shows the disadvantages and blue color box shows advantages of IP Culture.

14.4. Role of IP in Nation Building

Mark F. Schultz, School of Law, George Mason University stated that "**One of the challenges holding India back likely is the less-than-full development of its intellectual property system**.

Innovators and creators need to be able to secure their investment in developing their creations — or they often simply won't create, and they surely won't invest in commercializing and bringing products to market. Research shows that **stronger intellectual property rights are associated with a large number of outcomes likely to help a nation bridge the innovation gap**. Nations that protect intellectual property

- File more patents,
- Have more researchers,
- Invest more in R&D, and
- Enjoy more Foreign Direct Investment

It's time that India saw intellectual property as a tool for its own development. The last month saw the launch of the 'Make in India' campaign, wooing both domestic and foreign entities to manufacture and create products in India. **Unless this goes hand-in-hand with a relook at India's innovation ecosystem, the gains will be marginal**. With improvement in its intellectual property systems, India can bridge the innovation gap and assume its place as one of the world's leaders." [578]

Strong IP systems

- **Facilitate strong FDI**,
- Thereby producing more jobs for the people,
- Providing them better opportunities and
- Pumping capital into the economy.

Erosion of intellectual property is a key factor with respect to decisions being made regarding investing in India. The country, therefore, needs appropriate legislation, policies and legal decisions to reaffirm its stand on innovation and intellectual property. [63]

No country can afford to ignore the importance of intellectual property rights from economic, social and legal standpoints as it is a **critical driver of innovation** and ensures creativity, growth and progress. **India, with a large pool of traditional knowledge, must be careful to protect it**. [63]

Without IPR Culture, Indian economy can't grow. After 2005, the IPR culture is improving slowly but not as expected. The few examples are:

- The Indian drug industry will move from copying new molecules to creating new molecules. Piramal Life Sciences' breakthrough in a new molecule for head and neck cancer is an example. [475]
- New models of innovation started elsewhere. India simply copied them. Not anymore. CSIR's Open Source Drug Discovery is a workflow innovation using crowd sourcing for drug discovery, a true first. In just a couple of years it has 4500 participants from 135 countries! Conferences are being held in the USA now, discussing the Indian game changer OSDD in USA. [475]

14.5. IPR Culture in India

14.5.1. Excellent Researchers but Absence of Patent Culture

Our science leadership did not worry about protecting knowledge through patents. This is changing. Prof. C.N. R. Rao, India's most decorated scientist, **did not have a single patent to his name in five decades**. This year he has filed his first ever US patent on a breakthrough on hydrogen storage in graphene, an advanced carbon material. [475]

Prof. C. N. R. Rao, while answering the question "**You don't seem to have any patents to your name. Why is that?**" said that "I have not taken any patents. I don't know why (long pause). I didn't have the money. It takes about $15,000-$20,000 for each patent. No institute has the money for it. I can't put my own money. The Centre doesn't have the money. I would have probably taken 4-5 patents a year. That would be about $100,000, around Rs41 lakh." [476]

14.5.2. Poor IPR Performance

The Financial Express (Jan 2014) stated that "Significantly, figures show that as far as granting of patent is concerned, India has seen a sharp drop of 72.96 per cent from 2007-08 (15,261 granted) to 2012-13 (**4,126 granted**). For 2013-14, **2,185** patents have been granted up to November 2013." [430]

National Intellectual Property Organization (NIPO) Director T C James said that the government should carry out a comprehensive study to find out the main reasons for declining numbers of patent in the country. [431]

14.5.3. Dominated by Foreigners and Lack of Awareness in SME Sector

The Economic Times (March 2011) stated that "There are more foreigners than Indians receiving **patents in India**, prompting the government to say "much needs to be done to encourage more domestic innovations". In 2010-11, of the total 7,486 patents granted, **Indians could claim only 1,272**. On the other hand, foreigners walked away with 6,214 patents." [431]

Thousands of small and medium enterprises (SMEs) in India are reported to be **losing millions in revenues due to lack of awareness about IPRs** (intellectual property rights). About 40,000 IP applications are filed in India annually and **85 per cent of these are filed by multinational corporations**, leaving a sizable number filed by SMEs. D R Agarwal, director, ITAG (Innovation Technology Advancement Gateway) Business Solutions Ltd, Kolkata, said most innovations across the world are done by SMEs…**About 80 per cent of China's patent applications are filed by small companies**. This is the reason for China's global competitive advantage, said Agarwal. [434]

There is a vast discrepancy between the number of "patent applications" and "patents grated". The actual figure of "patents grated" is always quite small.

The Controller-General of Patents, Designs, Trademarks and Geographical Indications, under the Ministry of Commerce and Industry, says there has been a spurt from domestic companies seeking patents. The total number of patent applications, for instance, increased from 36,812 in 2008-09 to **43,674** in 2012-13. Of the 43,674 patents filed in FY13, over **78 per cent were international applications and 22 per cent local**. The local demand for patents is marginally up: in 2011-12, of the 43,197 patent applications filed, 80 per cent were foreign. In **March 2014**, TCS Ltd topped the list of IT patent filers with 162 applications followed by Samsung India Software Operations with 135 applications, Infosys with 81, Tejas with 40 and HCL with 36. The other organizations applying for patents are Biocon, Titan, TVS, Indian Institute of Science, ISRO, MS Ramaiah School of Advanced Studies and the Jawaharlal Nehru Centre for Advanced Scientific Research. The Tata companies too are going all out to garner as many patents as possible. [419]

The United Nation's intellectual property agency, the World Intellectual Property Organizations (WIPO), recently reported that their annual international patent applications surpassed the **200,000 mark** for the first time ever. Of the 205,300 applications, **56%** of patent applications were from the **US** while **29%** were from **China**. Interestingly, **India, with 1,392 applications**, is the largest user of the PCT system among low- and middle-income countries… Although, Fink does admit that every patent might not necessarily ensure uniform productive growth. “Some patents do make greater contributions to progress than others. Similarly, certain industries such as pharma have more ongoing research resulting into more patents” he concludes.” [420]

14.5.4. Few Examples from Industry

Council of Scientific & Industrial Research (CSIR) is an autonomous body under MOST with a network of 37 research laboratories (subject-specific) spread over the entire country. It owns a total of 3,016 patents out of which **1,770 are international** and 1,246 are Indian. The focus of CSIR is global participation with local elements. The organization has started partnering with large national and international companies in the development of core technologies that could help people at the grassroots. [394]

Bhabha Atomic Research Centre (BARC), engaged in atomic research, has developed 149 technologies out of which 93 have been commercialized. [394]

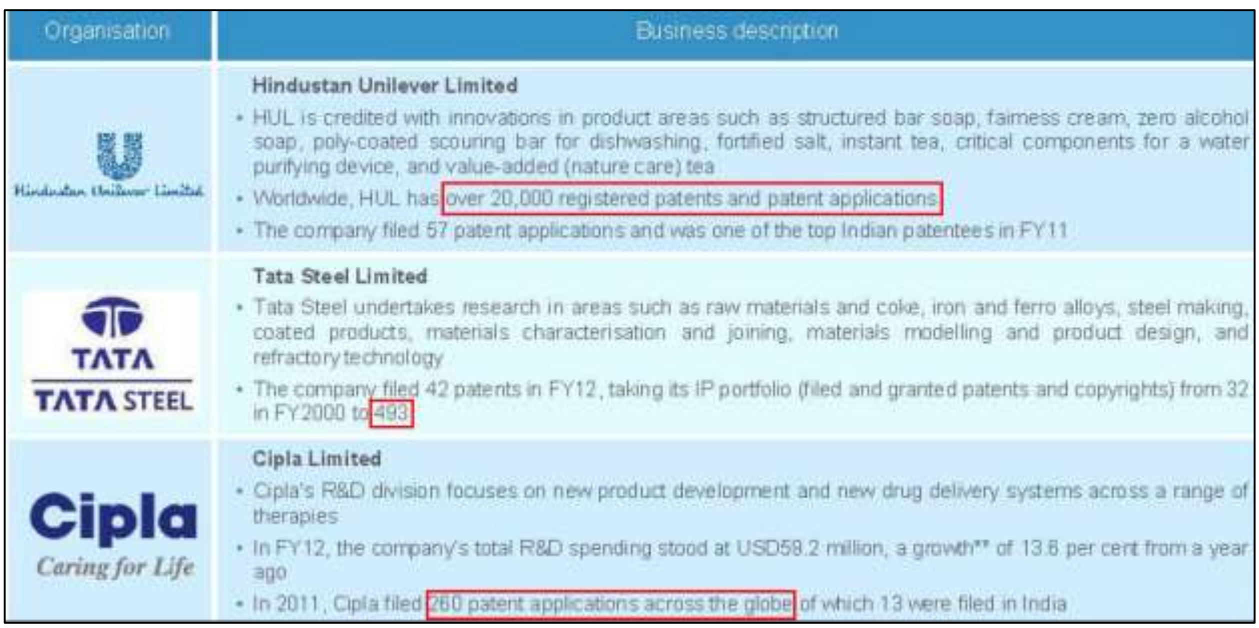
Indian Oil Corporation Limited (IOCL), one of the public sector ‘Navaratna’ (Nine Gems) companies, is engaged in the business of lubricants and grease formulations. It is one of the six worldwide holders of marine oil technology. During 2009-2010, IOCL developed 181 lubricants out of which 135 have been commercialized. It owns **215 patents**. [394]

In **Tata Group** the Major Listed companies are Tata Steel, Tata Motors, Tata Consultancy Services, Tata Power, Tata Chemicals, Tata Global Beverages, Indian Hotels, Tata Communications and Titan, which covers sectors like IT & Communications, Engineering, Materials, Energy, Services, Chemicals, Consumer products

- Over 90 operating companies
- In over 80 countries; six continents; exports to 85 countries
- Total revenue: $67.4 billion with 57% outside India
- 395,000 people worldwide
- Over 140 years old
- Combined market capitalization of about $106.04 billion (end2010); 3.5 m shareholders

Patent Activities

- Tata Steel: 483 domestic filings; 24 international filings. Tata Steel boasts of 1,200-plus patents
- Tata Motors: 661 patent filings including 93 foreign filings and 43 PCT filings. Tata Motors' Nano owns 31 design and 37 technology patents.
- Tata Communications : 67 patent filings including 47 in the USA and 14 in Canada
- Tata Chemicals: 52 patent filings including 32 from its Innovation Centre -on nanotech; biotech, chemicals [419] [428]



Organisation	Business description
Hindustan Unilever Limited	**Hindustan Unilever Limited** • HUL is credited with innovations in product areas such as structured bar soap, fairness cream, zero alcohol soap, poly-coated scouring bar for dishwashing, fortified salt, instant tea, critical components for a water purifying device, and value-added (nature care) tea • Worldwide, HUL has over 20,000 registered patents and patent applications • The company filed 57 patent applications and was one of the top Indian patentees in FY11
TATA / TATA STEEL	**Tata Steel Limited** • Tata Steel undertakes research in areas such as raw materials and coke, iron and ferro alloys, steel making, coated products, materials characterisation and joining, materials modelling and product design, and refractory technology • The company filed 42 patents in FY12, taking its IP portfolio (filed and granted patents and copyrights) from 32 in FY2000 to 493
Cipla Caring for Life	**Cipla Limited** • Cipla's R&D division focuses on new product development and new drug delivery systems across a range of therapies • In FY12, the company's total R&D spending stood at USD58.2 million, a growth** of 13.6 per cent from a year ago • In 2011, Cipla filed 260 patent applications across the globe of which 13 were filed in India

Fig. 14.4: IBEF Presentation: Key Players in Private Sector Companies [417]

14.5.5. Sector Wise Information

Report on Thomson Reuters Derwent World Patent Index 2013 (DWPI) stated that "The technology areas in India with the largest volume of innovation are **Pharmaceuticals, Computing & Control, Communications, and Transportation**.

- Within Pharmaceuticals and Transportation, innovation is especially prevalent from Indian companies.
- Innovation in Computing & Control and Communications shows a wider mix of Indian and foreign concerns." [403]

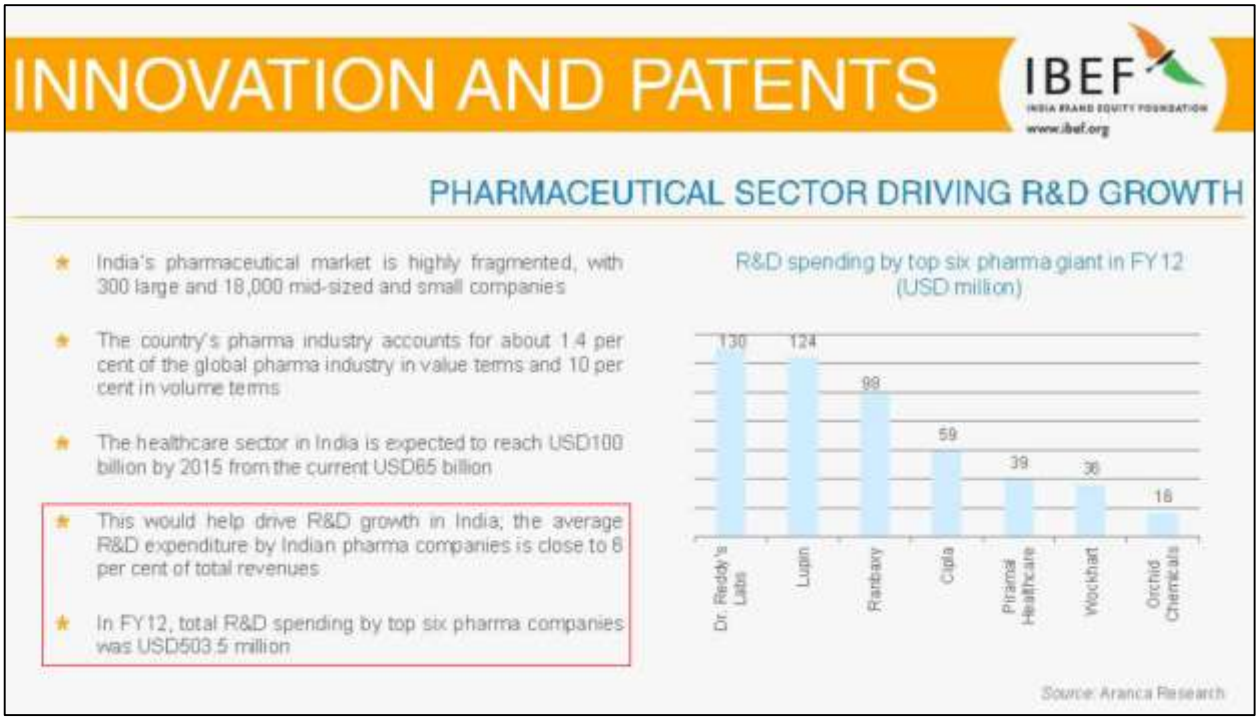


Fig. 14.5: IBEF Presentation: Pharmaceutical Sector Driving R&D Growth [417]

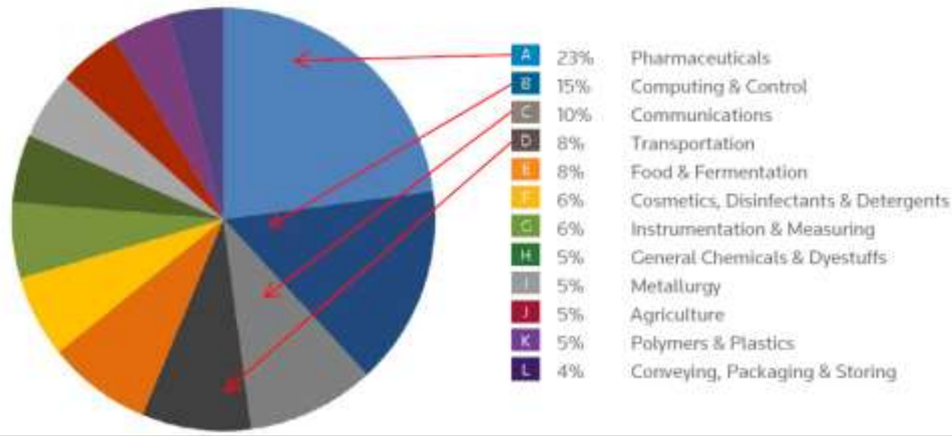
		2012 volume	2012 ranking	% of total
A	Pharmaceuticals	1,586	1	23%
B	Computing & Control	1,058	2	15%
C	Communications	678	3	10%
D	Transportation	579	4	8%
E	Food & Fermentation	552	5	8%
F	Cosmetics, Disinfectants & Detergents	436	6	6%
G	Instrumentation & Measuring	401	7	6%
H	General Chemicals & Dyestuffs	361	8	5%
I	Metallurgy	357	9	5%
J	Agriculture	326	10	5%
K	Polymers & Plastics	312	11	5%
L	Conveying, Packaging & Storing	289	12	4%

Source: Thomson Reuters Derwent World Patents Index (DWPI)

Table. 14.1: India Patent Activities in 12 Key Technology Areas [403]

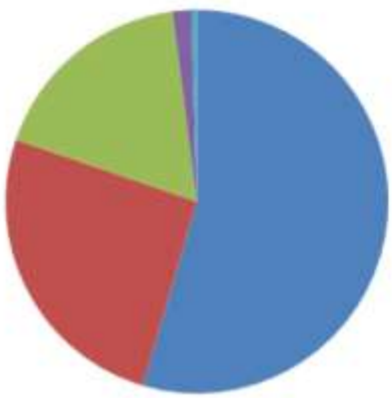
2012 PATENT ACTIVITY

OVERVIEW OF 12 KEY TECHNOLOGY AREAS



2012 PATENT ACTIVITY

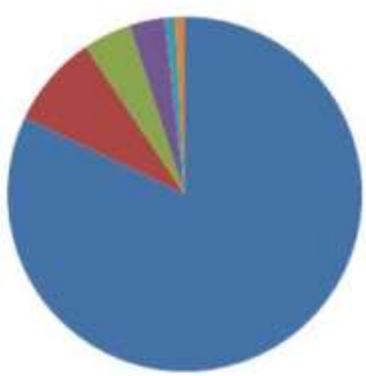
PHARMACEUTICALS



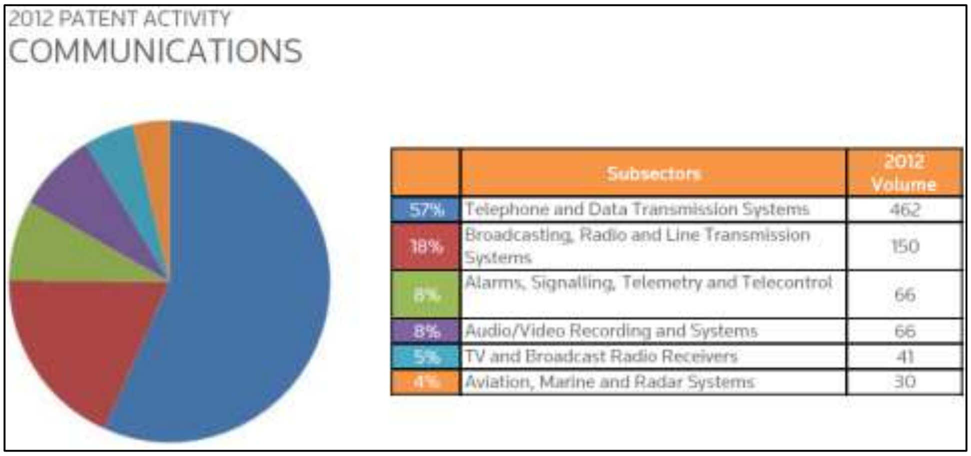
	Subsectors	2012 Volume
54%	Organics	1,065
25%	Natural products& polymers	500
18%	Tablets	346
2%	Steroids	31
1%	Inorganics	9

2012 PATENT ACTIVITY

COMPUTING & CONTROL



	Subsectors	2012 Volume
82%	Computers	949
9%	Computer Peripherals	98
4%	ATM Systems	51
3%	Process and Machine Control	37
1%	Traffic Control Systems	11
1%	Data Recording	10



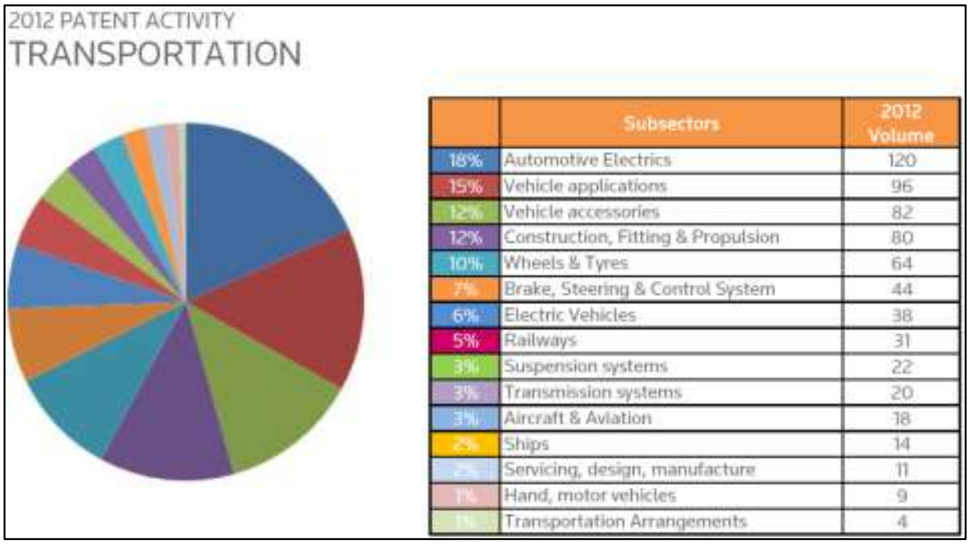
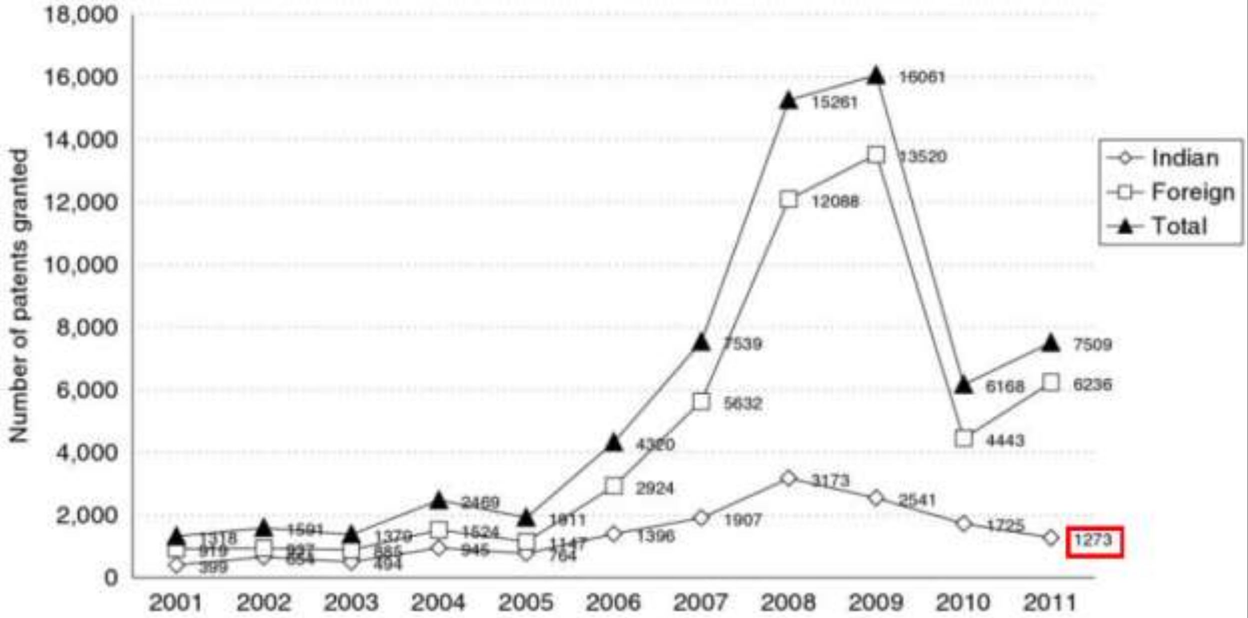


Fig. 14.6: India Patent Activities in 12 Key Technology Areas [403]

14.6. IBM: Produces 3.7 Times More Patents than Entire India

Just compare the following figure and table with the table of patent data of "top 25 Companies of the World by Number of Patents Granted in 2012". In 2012, India has produce just 1734 patents whereas IBM has produced 6478 patents. The **IBM (USA)** has capability to produce **3.7 times more Patents than entire India.** Similarly, **Samsung (South Korea)** has produced **2.9 times more patents than India.**



Source: Office of the Controller General of Patents, Designs and Trade Marks and Geographical Indications (various issues).

Figure 3.1 Trends in the number of patents granted to Indian and foreign inventors by the India Patent Office, and to Indian inventors by the USPTO

Fig. 14.7 Trends in the number of Patents Granted to Indian and Foreign inventors by the India Patent Office, and to Indian inventers by the USPTO [432]

SN	Origin	2010	2011	2012	2013
1.	Japan	46977	48256	52773	54170
2.	Germany	13633	12967	15041	16605
3.	Taiwan	9636	9907	11624	12118
4.	Korea, South	12508	13239	14168	15745
5.	United Kingdom	5029	4908	5874	6551
6.	France	5100	5023	5857	6555
7.	Canada	5513	5756	6459	7272
8.	Italy	2254	2333	2546	2930
9.	Switzerland	1889	1865	2039	2466
10.	Netherlands	1920	2048	2193	2572
11.	Sweden	1594	1863	2264	2431
12.	Australia	2079	2215	1786	1924
13.	China	3303	3786	5341	6597
14.	Israel	1917	2108	2598	3152
15.	Finland	1232	1023	1138	1297
16.	Belgium	896	958	1004	1148
17.	Austria	905	927	987	1135
18.	Denmark	766	840	978	1109
19.	China, Hong Kong S.A.R.	716	658	739	756

20.	**India**	**1137**	**1259**	**1734**	**2474**
21.	Spain	492	565	728	772
22.	Singapore	633	696	841	857
23.	Norway	448	412	474	520
24.	New Zealand	232	255	293	299
25.	South Africa	142	144	158	181

Table 14.2: Number of Patents Granted as Distributed by Year of Patent Grant [433]

Global Rank	Name of Company	Country	Total Number of Patents Granted in 2012
1.	IBM	USA	6,478
2.	Samsung Electronics	South Korea	5,081
3.	Canon	Japan	3,174
4.	Sony	Japan	3,032
5.	Panasonic	Japan	2,769
6.	Microsoft	USA	2,613
7.	Toshiba	Japan	2,447
8.	Hon Hai Precision Industry	Taiwan	2,013
9.	General Electric	USA	1,652
10.	LG Electronics	South Korea	1,624
11.	Fujitsu	Japan	1,535
12.	Seiko Epson	Japan	1,461
13.	Hitachi	Japan	1,436
14.	Ricoh	Japan	1,410
15.	Hewlett-Packard Development	USA	1,394
16.	GM Global Technology Operations	USA	1,377
17.	Qualcomm	USA	1,292
18.	Intel	USA	1,290
19.	Toyota Jidosha	Japan	1,285
20.	Broadcom	USA	1,157
21.	Google	USA	1,151
22.	Apple	USA	1,136
23.	Honda Motor	Japan	1,132
24.	Sharp	Japan	1,118
25.	Xerox	USA	1,050

Table 14.3: Top 25 Companies of the World by Number of Patents in 2012 [429]

One of the reason for this low Innovation Rate is R&D investment. Let's see following Tables. In 2012, India's R&D spending was PPP US$ Billion 40.3 and in 2011 the Toyota (Japan) has spent US$ Billion 9.9. That is India has spent approximately 4 times more than Toyota, whereas US has spent approximately 42 times more than Toyota. On the top of this India's spending on Industrial R&D is always below 1% of GDP.

Table III. Top-10 R&D Spenders in the World, 2012 and 2013

Country	2012 GERD (PPP US$ Billion)	2012 R&D as % of GDP	2013* GERD (PPP US$ Billion)	2013* R&D as % of GDP
US	418.6	2.68	423.7	2.66
China	197.3	1.60	220.2	1.65
Japan	159.9	3.48	161.8	3.48
Germany	90.9	2.87	91.1	2.85
South Korea	55.8	3.45	57.8	3.45
France	50.4	2.24	50.6	2.24
India	40.3	0.85	45.2	0.90
UK	42.0	1.84	42.4	1.84
Russia	37.0	1.48	38.5	1.48
Brazil	29.5	1.25	31.9	1.30

Note. *: Figures for 2013 are forecast; GERD: Gross Expenditure on R&D

Source: *Battelle and R&D Magazine,* 2013 Global R&D Funding Forecast, December 2012.

Table 1.4: R&D spending of top 10 nations of the world. [390] [392]

Rank 2011	Rank 2010	Company	R&D Spending 2011, $US Billions	Change from 2010	As a % of Sales	Headquarters Location	Industry
1	6	Toyota	$9.9	16.5%	4.2%	Japan	Auto
2	3	Novartis	$9.6	5.5%	16.4%	Europe	Healthcare
3	1	Roche Holding	$9.4	-2.1%	19.6%	Europe	Healthcare
4	2	Pfizer	$9.1	-3.2%	13.5%	North America	Healthcare
5	4	Microsoft	$9.0	3.4%	12.9%	North America	Software and Internet
6	7	Samsung	$9.0	13.9%	6.0%	Asia	Computing and Electronics
7	5	Merck	$8.5	-1.2%	17.6%	North America	Healthcare
8	11	Intel	$8.4	27.3%	15.5%	North America	Computing and Electronics
9	9	General Motors	$8.1	15.7%	5.4%	North America	Auto
10	8	Nokia	$7.8	0%	14.5%	Europe	Computing and Electronics
11	14	Volkswagen	$7.7	26.2%	3.5%	Europe	Auto
12	10	Johnson & Johnson	$7.5	10.3%	11.6%	North America	Healthcare
13	16	Sanofi	$6.7	15.5%	14.4%	Europe	Healthcare
14	12	Panasonic	$6.6	6.5%	6.6%	Japan	Computing and Electronics
15	17	Honda	$6.6	15.8%	6.5%	Japan	Auto
16	13	GlaxoSmithKline	$6.3	3.3%	14.3%	Europe	Healthcare
17	15	IBM	$6.3	5.0%	5.9%	North America	Computing and Electronics
18	19	Cisco Systems	$5.8	9.4%	13.5%	North America	Computing and Electronics
19	26	Daimler	$5.8	26.1%	3.9%	Europe	Auto
20	18	AstraZeneca	$5.5	3.8%	16.4%	Europe	Healthcare
		TOP 20 TOTAL:	$153.6	9.9% Avg.	8.3% Avg.		

Source: Bloomberg data, Booz & Company

Table 14.5: Top 20 R&D Spender companies of the world [391]

14.7. Importance of IPR in USA Economy

The Article published at US Chamber of Commerce website stated that "Intellectual property (IP) is the **economic currency of the 21st century**. Businesses that rely on IP account for more than **$5.8 trillion of U.S. GDP**, drive **74% of U.S. exports**, and support more than **55 million American jobs**. IP provides the incentives for the world's most innovative minds to develop cures for deadly diseases, productivity-enhancing software, safe and plentiful food supplies, and clean energy technologies. IP rights also enhance our cultural life. [436] [437]

14.8. Globalization Changed the Scope of Property

Globalization may be understood as the "rapid integration of good and services over borders both real and virtual." Added to the increasing speed of integration of goods, the exponential development of new digital technologies have completely **change the scene of "property" and market, the balance of power, the relations between means of production, diffusion, receptions and consumptions**. [443]

14.9. IPR, GATT (1948), WTO (1995) and TRIPS (1995)

The **World Trade Organization (WTO)** is an organization that intends to supervise and liberalize international trade. The organization officially commenced on 1 January 1995 under the Marrakech Agreement, replacing the **General Agreement on Tariffs and Trade (GATT),** which commenced in 1948. The GATT was the only multilateral instrument governing international trade from 1946 until the WTO was established on 1 January 1995. The organization deals with regulation of trade between participating countries by providing a framework for negotiating and formalizing trade agreements and a dispute resolution process aimed at enforcing participant's adherence to WTO agreements, which are signed by representatives of member governments and ratified by their parliaments. Most of the issues that the WTO focuses on derive from previous trade negotiations, especially from the Uruguay Round (1986–1994). [444]

The World Trade Organization (WTO) is "the only global international organization dealing with the rules of trade between nations. The goal is to help producers of goods and services, exporters, and importers conduct their business." It provides a set of trade agreements, and a dispute resolution process. It has now 153 members as well as 30 observers. [443]

The Agreement on **Trade-Related Aspects of Intellectual Property Rights (TRIPS)** is an international agreement **administered by the World Trade Organization (WTO)** that sets down minimum standards for many forms of intellectual property (IP) regulation as applied to nationals of other WTO Members. It was negotiated at the end of the Uruguay Round of the General Agreement on Tariffs and Trade (GATT) in 1994. The document establish the minimum requirement that member states must provide regarding intellectual property rights (IPR). As example, copyright must extend to at least 50 years after the author's death, it must be granted automatically (not registration needed), computer programs must be regarded as literary work, and patents must be enforceable for at least 20 years. Those requirements are generally regarded as "**strong" IPRs**. [445] [443]

Specifically, **TRIPS requires WTO members to provide** copyright rights, covering content producers including performers, producers of sound recordings and broadcasting organizations; geographical indications, including appellations of origin; industrial designs; integrated circuit layout-designs; patents; new plant varieties; trademarks; trade dress; and undisclosed or confidential information. TRIPS also specifies enforcement procedures, remedies, and dispute resolution procedures. Protection and enforcement of all intellectual property rights shall meet the objectives to contribute to the promotion of technological innovation and to the transfer and dissemination of technology, to the mutual advantage of producers and users of technological knowledge and in a manner conducive to social and economic welfare, and to a balance of rights and obligations. [445]

The obligations under TRIPS apply equally to all member states, **however developing countries were allowed extra time to implement** the applicable changes to their national laws, in two tiers of transition according to their level of development. The transition period for developing countries expired in 2005. The transition period for least developed countries to implement TRIPS was extended to 2013, and until 1 January 2016 for pharmaceutical patents, with the possibility of further extension. [445]

14.10. Twisted Game

Since TRIPS came into force it has received a **growing level of criticism from developing countries**, academics, and non-governmental organizations. Some of this criticism is against the WTO as a whole, but many advocates of trade liberalization also regard TRIPS as bad policy. TRIPS's wealth concentration effects (**moving money from people in developing countries to copyright and patent owners in developed countries**) and its imposition of artificial scarcity on the citizens of countries that would otherwise have had weaker intellectual property laws, are common bases for such criticisms. [445]

Who actually owns knowledge? In 2000, **90% of the world's patent were held in the North**. According to a WIPO document of 1998, citizens from developed countries hold 95% of African patents, 85% of Latin American patents and 70% of Asian Patents. Not only that, but **the patent game is a twisted one**. About **two thirds of patents are never produced, but used only to ward off rivals**. Studies establish the use of **intellectual property rights to establish market powers**. This use appeared clearly in the recent acquisition by Google of Motorola Mobility for approximately $12.5 billion: in the transaction, Google acquired 17'000 granted patents and 7'000 pending patents, "which will enable us to better protect Android from anti-competitive threats from Microsoft, Apple and other companies." **It is clear that in this context, any developing country's industry is largely paralyzed in the global market**. And patents are further threatening, for life form, if modified, can be patented. Barrientos (2002) gives a few examples. **Neem was used as a pesticide by women in India** for years. Now, it has **35 patents in the US**

and the EU. Brazzein is a substance found in West African berry, five hundred times sweeter than sugar. An isolated protein is patented in US and EU, and no plan are made in making West African people share in the estimated US$100 billion a year market. An enactment of the TRIPS agreement would enable the global privatization of food resources in general. For African communities, this is a question of life. "They depend for their lives and livelihoods on biodiversity and indigenous knowledge, vulnerable to the greed, hoarding and abuse of bio-pirates and their commercial interests." [443]

A few days ago, the US told Russia it would be impossible for the country to join WTO if it doesn't shut down a website selling western music without any license. At the same time, the European Union told China it was high time to stop being comprehensive with all the counterfeiting goods exported from the country. **Why intellectual property -copyrights, patents, trademarks- is so important in globalization today?** It's one of the main topics because the developed countries decided it was. For them, globalization lead to a new worldwide specialization: China, India and the South would manufacture cheap products, and Western countries would specialized in high value added work: innovation and creativity. That's a simple globalization project: knowledge, culture, innovation and global trademarks for the North; cheap labor and manufacturing for the South. That was a kind of naïve vision, as we see right now with China or India, which are more and more able to produce and export high value works. But that's the vision still used by Western countries to push for worldwide rules of protection for knowledge and innovation. And they ask for a special kind of protection: they say that knowledge, culture and innovation deserve to be protected, in the same kind of manner we protect a car, a house or a piece of land, by property. That's what IP now is: a property-like rule of law on an immaterial stuff. An exclusive right given to someone to forbid the copy of something it would be easy to copy without IP rules. It now very easy to duplicate a book or a film, only copyrights forbids that. It's nearly easy to build a car imitating the way Renault or General Motors do it. But hundreds of patents forbid it. The most important shift in IP these years was the **TRIPS treaty**, which is part of the WTO negotiations. TRIPS aims at harmonizing patents and copyrights all around the world, in an unprecedented move. [442]

So, in the end, who will benefit from the application of the TRIPS agreement in developing countries? FDI will rise, as well as licensing, since most developing countries are importers of technology from developed countries, and the strong IPRs will allow enterprises to extend their markets without fearing "piracy". The World Bank estimates a large benefice for developed nations in this new market. For example, it estimated a **$19 billion benefit per annum for the USA**. Given that a large majority of patents are held in developed countries, "**patent protection is likely to lead to a transfer of income from the less-developed countries to the more-developed countries and thereby widen the income disparities between the two**." According to Hindley (2006), we cannot be sure of the global gain that will arise from IPRs enforcement, since we cannot be sure that stronger IPR will stimulate creativity and innovation. But "the belief that the TRIPS agreement creates, or will create, a transfer of substantial wealth from the residents of poor countries to the residents of rich countries has a much firmer basis." This transfer of wealth gives the impression that "the WTO is a vehicle for the exploitation of poor countries by rich ones,", and plays a major role in the negative view of the WTO from developing countries. [443]

For detailed information, kindly refer the research publication (33 pages) “Globalization and Intellectual Property: How does the TRIPS agreement affect developing nations” by Olivier Keshavjee and Dr. Malcom Damon, Stellenbosch University, South Africa (2011). [443]

14.11. IP Under Attack

However, **IP is under attack around the world**. Counterfeiters and pirates have built a global criminal enterprise that destroys jobs, undermines innovation, and endangers consumers. IP is also under threat by some activists and a handful of governments that promote the view that IP rights are an obstacle, rather than a catalyst, to economic development and growth.” [436] [437]

14.12. Indian IPR Legal Issues & USA Stand

Despite the current decade being called India’s “decade of innovation”, the country has been ranked at the bottom of the list of 25 countries in terms of its intellectual property (IP) environment. According to the 2014 International Intellectual Property (IP) Index by the US Chamber of Commerce’s Global Intellectual Property Center (GIPC), India’s percentage score has fallen from 25 per cent in 2012 to 23 per cent. “**The continued use of compulsory licenses, patent revocations, and weak legislative and enforcement mechanisms raise serious concerns about India’s commitment to promote innovation and protect creators**,” the report said. [421]

Independent India started off with a fairly strong intellectual property protection system, a carryover from the system that protected the rights of British inventors under the colonial regime. However, there was growing disquiet about this system in the first two decades after independence, particularly in the area of pharmaceuticals, where **strong patent-protection was seen as enabling multinational drug companies to extract monopoly profits from a poor country**. This culminated in India making **important amendments to the Patents Act**, including the **removal of provisions to patent new molecules**, and providing **relatively short periods of patent protection in all cases**. The new legislation— the Patents Act, 1970—is commonly credited with the growth of India’s generic pharmaceutical industry (based on an ability to create new processes for known drugs and scale them up effectively) as well as of the lowest priced drugs in the world. By the 1990s, many things had changed. Globalization was the order of the day, and India also moved towards globalization, joining international talks aiming to provide a supportive environment for global trade. These talks expanded in scope to incorporate intellectual property protection. In 1995, India signed up for the World Trade Organization treaty and promised to put in place stronger intellectual property laws by January 1, 2005… There has been reasonably widespread acceptance of the amendments to the Patents Act made in 2004, 2005, and 2006 [399]

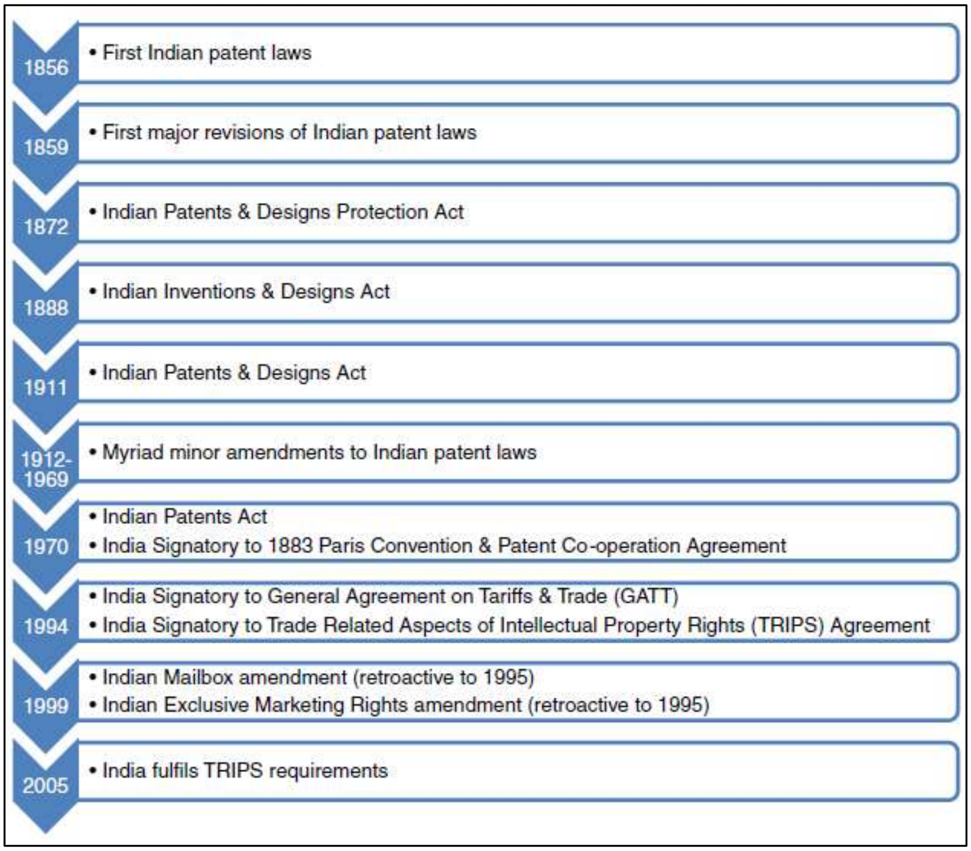


Fig. 14.8: History of Indian Patent Laws [418]

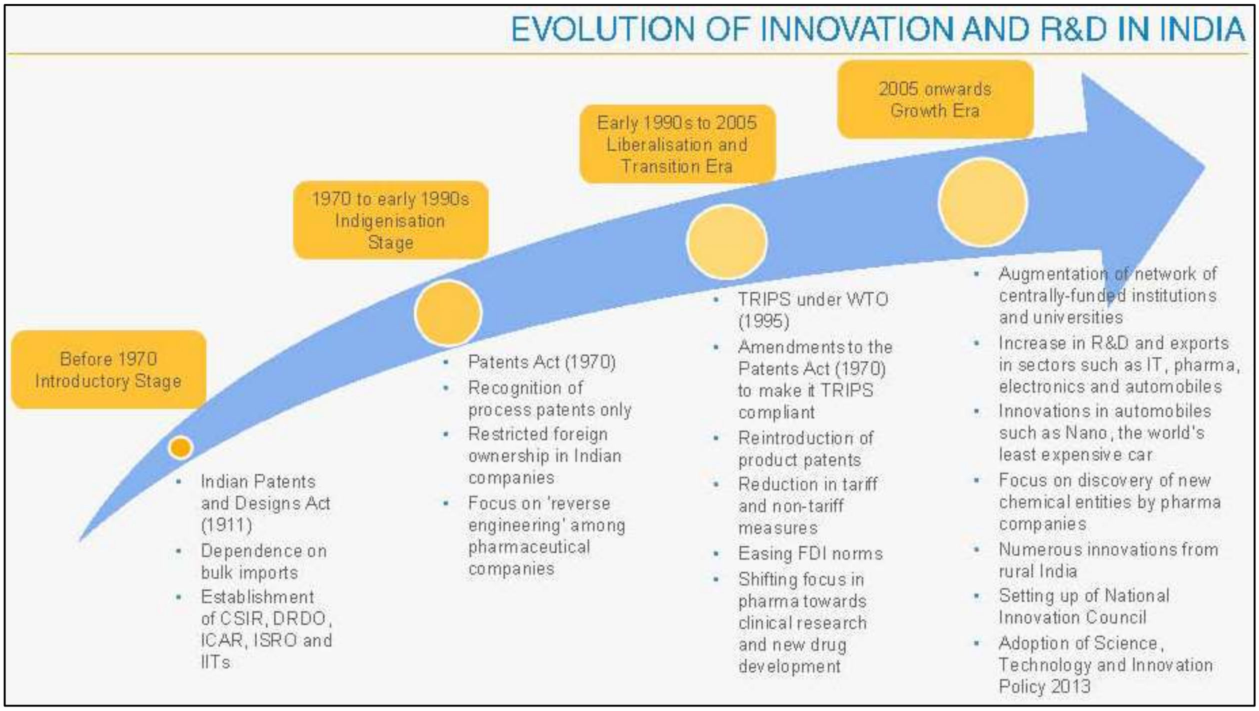


Fig. 14.9: IBEF Presentation: Evolution of Innovation and R&D in India [417]

Fig. 14.10: Presentation by Dr. R. A. Mashelkar, Director CSIR: Indian Pharmaceutical Industry [206]

The Indian drug and pharmaceutical industry has gone through a similar process. Indian IP laws were designed in such a way that **only process patents were accepted, but product patents were not.** In response, **the Indian industry created a strong base by copying new molecules introduced in the Western world.** This was perfectly legitimate, but it also meant that there was no drive to create new molecules. On 1 January 2005, in fulfillment of its TRIPS obligation, Indian IP laws were changed, and product patents became acceptable. In anticipation of the change, the drug/pharmaceutical industry began investing heavily in innovation. Research portfolios changed from innovative process chemistry to innovative product development, including developing new molecules and new drug delivery systems. Investment in R&D, which had hovered around 1–3% of sales turnover, began to climb, in some cases reaching 10–15%. [229] [230]

I would like to quote the points from the article published in Financial Express by Mr. Patrick Kilbride, Executive Director, International IP, at the Global Intellectual Property Center, US Chamber of Commerce.

- Notwithstanding this tremendous allure, global corporations have found **it difficult to do business in India in recent years**. Interventionist government policies created a sense—in some cases, a reality—that **the rules were arbitrary and subject to sudden, even retroactive, change**. This was particularly the case **for industries that rely on intellectual property rights to finance the capital-intensive research and development** that is necessary for the introduction of life-changing new products such as medicines and health care technology. Even the threat of compulsory licensing and patent revocations was sufficient to create the legal uncertainty that is **anathema to investment in innovation**. One widely-cited report, the International Intellectual Property Index researched by the Israel-based Pugatch Consilium and published by the US Chamber of Commerce, found

India ranked last among 25 key global markets on the regulatory and governance factors most closely watched by global innovative industries. Accordingly, the inauguration of Indian Prime Minister Narendra Modi this past May was welcomed by the international business community as a critical opportunity to refresh a relationship with the Indian government that had reached a stalemate. Since then, anxious investors have awaited a signal that the new government was serious about its rhetoric of a newly competitive Indian business climate. With Tuesday's announcement by commerce and industry minister Nirmala Sitharaman of a **new Indian government policy to promote intellectual property**, the waiting could be over. "**India needs to aggressively tell the world that we believe in intellectual property rights,**" said Amitabh Kant, secretary of the commerce and industry ministry, according to press reports. [165]

- An intellectual property policy that puts India among the world's standard-setters for innovation would include the following elements:
  - A principled commitment to the legal rights of patent, copyright, and trademark rights holders, as well as legal protection of trade secrets;
  - Ratification and implementation of key international intellectual property treaties, such as the Patent Law Treaty and other World Intellectual Property Organization (WIPO) treaties, the Berne Convention, and the Singapore Treaty on the Law of Trademarks;
  - Refutation of compulsory licensing (CL) as a commercial tool, and a policy of rejecting CLs except in emergency situations as defined by the World Trade Organizations Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS);
  - Patentability requirements based solely on the TRIPS criteria of novelty, inventive step, and industrial applicability;
  - Streamlining of IP-related bureaucracies to permit the efficient registration of patents, copyrights, and trademarks, and the enforcement of the same. [165]
- Countries that earn a reputation for promoting and protecting the creation of intellectual capital reap important domestic benefits:
  - They incentivise the substantial R&D investments necessary for the location of capital-intensive industries and the jobs they create;
  - They foster a legal and financial infrastructure that enables the successful commercialization of new products by small-scale innovators; and,
  - They ensure their citizens the earliest possible access to the newest technologies. [165]

From a self-described "consumer" of intellectual property, India could become the pathfinder for new avenues of global innovation. [165]

George T. Haley, Usha C.V. Haley in their research paper (13 pages) titled "The effects of patent-law changes on innovation: The case of India's pharmaceutical industry" stated that "Political and legal considerations regarding **greater social returns triggered changes** to the Indian pharmaceutical industry's regulatory and institutional environments for innovation. In the 1960s, the British company, ICI Pharmaceuticals developed the high-blood-pressure medication, propranolol, the first beta blocker that inhibits fight-or-flight hormones such as adrenaline. But, many Indians found the drug expensive. Yusuf Hamied, head of R&D at Indian company Cipla, and the CEO's son, started manufacturing a cheaper version for the Indian market. ICI protested to the Indian government, and Hamied used prior legal opinions to justify his actions as corresponding with national interests to then Prime Minister Indira Gandhi. In 1959, Justice Rajagopala Ayyangar had issued a report urging that **for national interests a partial process-**

patent regime become the law in India. The legal and political arguments appeared to persuade Indira Gandhi. In 1970, she urged parliament to change the laws governing drug patents, applying the laws **not to the chemical compounds themselves but to the processes used to manufacture them**. Until December 31, 2004, India's regulatory and institutional environments in pharmaceuticals and agro-chemicals **limited patent protection to providing exclusive rights only to processes through which the products were produced, rather than to the products**. **These environments allowed India's innovative, high-quality and low-cost pharmaceutical industry to develop, to produce and to sell legally in developing countries, low-cost Indian versions of high-cost Western pharmaceuticals without patent infringement**. Indian companies had the legal rights to produce and to sell drugs if their processes to produce the drugs differed sufficiently from the original patent holders' processes. On January 1, 2005, to meet the requirements for membership in the World Trade Organization (WTO), **India transitioned to a product-patent regime**. This regulatory and institutional change provides an opportunity for an early test of the premise that **product-patent regimes promote innovation**….Yet, unlike India, most of these other countries had **communist governments which did not recognize Western patents**; and, again, unlike India, most of their governments controlled and directed pharmaceutical research, production and distribution. Hence, India provides a close-to-ideal legal jurisdiction to test previously untested claims that pharmaceutical product-patent regimes result in greater rates of innovation, which in turn can improve social health and can contribute to greater social welfare and returns." This study indicates that **product-patent regimes do not necessarily generate greater rates of innovation than process-patent regimes**, and **may reduce innovation**. Our preliminary findings, together with those that we reviewed earlier, suggest that we should question our beliefs that strong product-patent regimes promote innovation. Indeed, substantial research needs to establish the true value of product-patent regimes to innovation, **especially in low-income markets where distribution of benefits assumes more importance**...Given the size and growth of the Indian pharmaceutical market and the rate of India's economic growth, **FDI in India's pharmaceutical industry may have occurred regardless of patent regime**. For detailed information, kindly refer this excellent research paper. [418]

In Production	In R&D and Associated Services	In Generics
•India's costs 50% lower than USA's and EU's	•$48 b potential market in 2007 •1.6% of Indian companies' sales goes to R&D vs. 15% for USA and EU. •India's costs for clinical research 1/10th of USA's and EU's •India's costs for research overall 1/8th of USA's and EU's •India's costs for basic research, 1/3rd of EU's	•$65 b potential global market in 2007 as USA's and EU's drugs lose patent protection •$19.5 b (30%) estimated to be India's market share of drugs losing patent protection

Fig. 14.11: Cost-based opportunities for India's pharmaceutical industry vs. the USA's and EU's. [418]

The article in Indian Express highlighted this issue and stated that "India had a few anxious moments on April 26 2014, when countries and companies globally observed World Intellectual Property Day. The cause of concern was **the possibility of the US blacklisting India for its intellectual property rights (IPR) regime**. A few days later came a partial reprieve as the US Trade Representative announced its decision to **keep India out of the Priority Foreign Country list**, which is a **classification of nations with poor IP laws**, but still on the priority watch list. "The US' concerns over India's IPR regime will affect the country's brand immensely, particularly at a time when India is opening up several sectors to foreign direct investment," says NC Hegde, partner, Deloitte Haskins & Sells. Trouble started last year, with the US pharma industry intensifying protests after Novartis' plea to patent its anti-cancer drug Glivec and Bristol-Myers Squibb its Sprycel were **rejected both by India's Intellectual Property Appellate Board and the Supreme Court**. The latter said the **drugs were not new medicines, but amended versions of a known compound**. This came as a **shock to the global players**. Glivec has been patented in nearly 40 countries. Indian law allows generic players to take up manufacturing for incremental innovations at lower prices; which is how Indian players like Natco and Cipla produce and sell a Glivec-like drug at a **93 per cent lower price**. "Indian law bans firms from extending patents on their products by making slight changes to a compound, a practice known as **ever-greening**. Otherwise, companies would retain patent exclusivity and continue to sell products at a premium price," explains Supreme Court lawyer Pavan Duggal." [419]

The recent Economic Times (4 Oct 2014) article stated that **India's intellectual property regime is fully compliant with WTO norms, the government said on Friday**, two days after the two countries decided to set up a high-level working group on IPR during Prime Minister Narendra Modi's US visit to sort out the contentious issue. "India has consistently pointed out that the **intellectual property right (IPR) legal regime in India is fully TRIPS compliant** and that any issues to be discussed have to be discussed in bilateral forums like Trade Policy Forum (TPF)," the department of industrial policy and promotion said in a release. [422]

The trend toward reform is already evident by moves in **South Africa to overhaul the country's patent laws** in an attempt to address concerns over the cost of drugs… "Economically, there is no massive impact so far but this could change if more products are involved," Bayer said, adding that if countries like **India are regarded as a "role model" for other countries**, "**IP protection could be diluted in several jurisdictions**." [435]

14.13. IP Commission Report on the Theft of American Intellectual Property (2013): Main Problem with China, India and Russia

The IP Commission Report on the theft of American Intellectual Property (2013) stated that "**Russia, India**, and other countries constitute important actors in a worldwide challenge…**China has been the principal focus** of U.S. intellectual property rights (IPR) policy for many years. As its economy developed, China built a sophisticated body of law that includes IPR protection. It has a vibrant, although flawed, patent system. For a variety of historical reasons, however, as well as because of economic and commercial practices and official policies aimed to favor Chinese entities and spur economic growth and technological advancement, **China is the world's largest source of IP theft.** The Impact of International IP Theft on the American Economy **Hundreds of billions of dollars per year**. The annual losses are likely to be comparable to the current annual level of U.S. exports to Asia—**over $300 billion**. **Millions of jobs**. If IP were to receive the same protection overseas that it does here, the American economy would add millions of jobs. **The Role of China Between 50% and 80% of the problem**. The major studies range in their estimates of China's share of international IP theft; many are **roughly 70%,** but in specific industries we see a broader range…International IP Theft Is Not Just a Problem in China. **Russia, India, and other countries constitute important actors in a worldwide challenge**. Many issues are the same: poor legal environments for IPR, protectionist industrial policies, and a sense that IP theft is justified by a playing field that benefits developed countries… Likewise, there is a lack of criminal sanctions for end-users in some countries where IPR violations are rife. **The two most populous nations in the world, India and China, suffer from inefficient judicial institutions, have weak criminal enforcement of IPR violations, and seldom impose sentences that would rise to the level of deterrence for IP crimes**… The USTR's 2013 Special 301 Report reviews the state of IPR protection and enforcement across the globe. In its most recent report on U.S. trading partners, the USTR identifies 1 priority country (**Ukraine**), while including 10 countries on its "**priority watch list**" and 30 on its "watch list." Most of these 41 countries are the subject of a sternly worded paragraph on problems in their IPR protection and enforcement. Beyond the special focus on Ukraine, however, 3 countries on the priority watch list warrant more extensive comments: **India, Russia, and China**… According to the USTR, the outlook for **Indian protection of IP is discouraging**, so much so that "there are serious questions about the future condition of the innovation climate across multiple sectors and disciplines." **Companies, for example, are challenged to patent and defend already patented pharmaceuticals**. If a recent case serves as a precedent, companies from many sectors may be forced into compulsory licensing if they wish to sell in the country but do not manufacture the product there… **The patent system encourages Chinese entities to copy and file foreign patents as if these patents were their own**, and seems to establish the right of Chinese entities to sue the foreign, original inventor that seeks to sell the technology in China. A deluge of such suits could occur in the next few years. Separately, proposed legal amendments are now circulating that would force foreign companies into licensing agreements in exchange for those companies' access to the Chinese market. The amendments would produce a situation similar to the one developing in **India, where foreign manufacturers may be prevented from importing their products and left with the choice of either licensing their technology to an Indian firm or manufacturing products in the country if they wish access to the Indian market**… The study by the Business Software Alliance estimates that the global piracy rate is 42%. The EU rate was judged to be 33%, Japan's is 21%, and the U.S. rate is 19%. However, the piracy rate for emerging economies is over 68%. **India's piracy rate is 63%** (a 9% decline over the last decade), Russia's rate is 63% (a 24% decline), and Indonesia's rate is 85%. Meanwhile, **China's illegal software market was $9 billion in 2011 out of a total market of nearly $12 billion, for an astonishing piracy rate of 77%.**" [423]

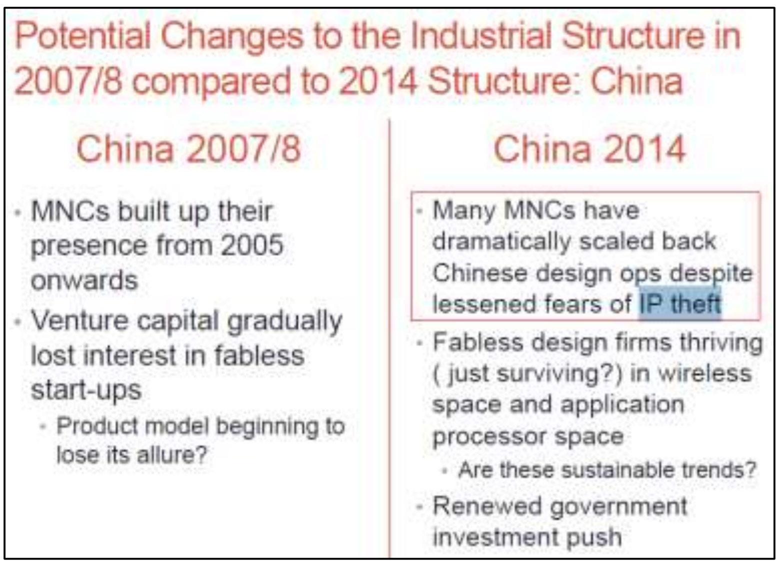


Fig. 14.12: China: Relation of MNC & poor IPR environment [424]

14.14. Views in Favor and Against IPR

Former intellectual property lawyer, turned social entrepreneur, Gautam John, weighs in, "Patents are not a proxy for innovation. I'd go so far to say that in many fields of work, **excessive patents harm innovation**… He shares the study by Petra Moser 'Patents and Innovation: Evidence from Economic History'. The paper suggests that patents might not have anything to with innovation after all…However, nearly half of all US plant patents between 1930 and 1970 were for roses, suggesting that the 1930 legislation may have missed its target of establishing food security… Chief Economist at WIPO Carsten Fink elaborates, "In general, **there is a co-relation between R&D investments by companies and countries, and increase in patent filings**… [420]

Fig. 14.13: Presentation by Dr. R. A. Mashelkar, Former Director CSIR: View in favor of and against IPR [206]

14.15. Major Disadvantages of Not Having IP Driven Culture

14.15.1. IP Driven Startup Companies

Deepam Mishra, CEO, i2india Ventures stated that "There is lot of startup activity and money but very little money in early stage, seed stage and almost **nothing in IP driven seed stage**. To

create IP driven businesses, you **have to have IP**. We have very little of that in the country. Most IP is created by either research institutions or offshoots of research institutions. IP is research driven and it requires a lot of work. A big part of that is missing. Most of our academic work is just academic and there is no connect to the real world. Even in big companies, the amount of real research is very little. Most of it is applied research or tweaking things which also requires effort. But to come up with a core technology that defines a cell phone, that kind of work doesn't happen. There is no IP ready to be exploited… Investment which goes into early stages is very low. Most early stage investors are small and they invest because they understand the risks. Since you don't have a series of companies which have become successful and entrepreneurs who have made money doing IP investment, very few investors have the knowledge or the risk appetite to invest in an IP driven company. They think the risk is too high. It might take two years to develop a product and then find that its a complete disaster. **IP companies are very different from standard software companies. The risk profile is different, the type of people who pursue it are very different**." [438]

14.15.2. Need IP Based Business Model & Not Companies Driven by Cost Advantages

So far Indian IT-BPM (Information Technology- Business Process Management) companies have achieved only **limited success in the field of IP**, their **initial growth having driven by the cost advantage** over the North America and European destinations. **In the IP space the Indian industry is very much in the initial stage**. According to various reports, the Indian IT firms spend just around 2% of their total revenues on research and development as compared to 7-8% by companies in North America. "**It is this gap the Indian companies need to address if they want to move up in the global innovation map**," said Pradeep Udhas, chairman of the Indian Global Programme at KPMG (India)… When India's IT-BPM industry is increasingly depending on innovation to achieve its projected growth of $300 billion by 2020 from the current size of $108 billion, creating, managing and monetizing intellectual property (IP)s is expected to drive the industry in the coming decade, KPMG In India report said today. [439] [440]

Sharing his views on the topic, Gary Matzusak, Global Chairman, Technology Media & Communications, KPMG LLP said, "Intellectual Property is critical in a world economy that is **increasingly dependent on innovation**. It is the **only legal way to convert innovation to money-**making asset and is therefore fast becoming the most valuable asset for successful companies. Indian firms should look at **creating business models driven by effectively leveraging and monetizing these IP capabilities** and target the global product market." [441]

14.15.3. Scientist Unable to Move towards IP Driven Research

Priority of commercial exploitation in research labs has never been there. Over 80% of India's research is publicly funded. The nation needs to know. Whatever funding was done, it was to help the industry and not to create new technologies. These labs were subsidized R&D labs for industries because we were trying to do import substitution for the first few years. Last 10 years, the world has turned upside down. Now everyone is talking about IPR and patents. **These scientists who have never heard of patents in their growing life are now being asked to make**

commercial patents. They have never looked at licensing. The whole idea of commercialization of IP is very new in research. [438]

14.15.4. Academics: Don't have Market Knowledge

Academics don't have market knowledge. They are all solving academic problems. Their source of market knowledge is from peers who are from outside the country. So they are often solving challenges that don't even apply to India. You can't expect them to be entrepreneurs. [438]

Chapter 15: Indian Visible & Invisible Innovations: Frugal Innovation & Indian "Jugaad Mindset"- The Secret Weapon of Emerging Markets

Frugal Innovation – "Functional solutions through few resources for the many who have little means."[97]

"The emerging middle class is the ***number one driver of innovation*** *among multinationals in rapid-growth markets. To succeed, companies will need to think about how to fulfill unmet needs and create entirely new* ***business models as well as product innovations****." - Andrea Vogel, Ernst & Young* [416]

*Take Carlos Ghosn, the CEO of the Renault-Nissan Alliance. In 2006, Ghosn coined the term "****frugal engineering****"—inspired by Indian engineers' ability to innovate cost-effectively (and swiftly) under extreme resource constraints. As Ghosn points out: "In the West, when we face huge problems and we lack resources, we tend to give up (too) easily. Jugaad is about never giving up!" Under Ghosn's leadership, Renault-Nissan has proactively adopted frugal engineering—and the underlying* ***jugaad mindset****—and established itself as a major global manufacturer of both low-cost vehicles as well as electric cars—two of the fastest growing segments in the global automotive market.* [85]

Frugal innovation has become the ***buzzword****. Indian innovation has changed the vocabulary of innovation. Words that did not exist five years ago dominate today.* ***In terms of non-technological innovations, we are among the leaders****. Jugaad has created the wrong image for India … with cost as the only consideration, with no consideration for safety, environmental impact, aesthetics and sustainability. Jugaad is about getting less from less.* ***We must go for what I call affordable excellence*** *– Dr. Raghunath Mashelkar, Former Director, CSIR* [119]

The report from the UK's innovation foundation, the NESTA (2012) stated that "frugal innovation could be an important source of competitive advantage for India, and a basis for strategic collaboration with Western countries. India's got the Frugal Factor at a time when frugal innovation has ever-greater relevance around the world. Today this strength has a new significance". [466]

"India should encourage low-cost innovations" - Gururaj Deshpande, Adviser to US President Obama [203]

15.1. Visible & Invisible Innovation of India

A useful perspective on Indian innovation is to distinguish between the **visible and invisible**. Kumar and Puranam investigated this in their 2011 book "India Inside". **Visible innovation -** where new products and services are created for end users **– is still at a nascent stage in India**. However, **invisible innovation is growing rapidly** and has now become well established. It falls into four categories.

1. **Globally segmented innovation**: how MNCs leverage Indian talent
2. **Outsourcing innovation**: R&D services on demand
3. **Process Innovation**: An injection of intelligence
4. **Management Innovation**: the global service delivery model [31]

Nirmalya Kumar, who is Number 26 on the Thinkers50 list said that "A lot of Indian innovation is invisible, but innovation nevertheless. And it is this 'invisible' innovation that is helping India." [507]

15.2. Frugal Innovation: A New Disruptive Business Paradigm

Frugal innovation is a flexible and inclusive approach to innovation that maximizes value for customers, shareholders, and society—while minimizing use of financial and natural resources. [451]

Watch the wonderful video at YouTube "India: Universe of frugal innovation - #DownToEarth"

Andrea Vogel, EMEIA Strategic Growth Markets Area Leader at Ernst & Young stated that "The emerging middle class is the **number one driver of innovation** among multinationals in rapid-growth markets. To succeed, companies will need to think about how to fulfill unmet needs and create entirely new business models as well as product innovations." [416]

Through minimizing the use of resources in development, production and delivery, or by leveraging them in new ways, **frugal innovation** results in dramatically lower-cost products and services. Successful frugal innovations are not only low cost, but outperform the alternative, and can be made available at large scale. Low cost doesn't mean low tech. On the contrary, frugal innovation can use highly sophisticated technology. Frugal innovation is not just low technology or cheaper versions of existing technologies. In some cases it combines low and high technology. In others, it creates new, more efficient systems for delivering technology, which makes them cheaper… Successful frugal innovations are not only low cost but outperform the alternative and can be made available at a large scale. Often, but not always, frugal innovations have an explicitly social mission. [448] [459] [466]

Between now and 2030, the number of people in the global middle class will **grow from 1.8 billion to 4.9 billion**. The vast majority of these three billion new consumers, with daily expenditure of between US$10 and US$100, will live in Asia and other rapid-growth markets…Between 2009 and 2030, demand from the global middle class could grow from US$21 trillion to **US$56 trillion**....There is a widespread consensus that **innovation in rapid-growth markets** represents an important opportunity for growth....Creating products and services that are affordable for the next three billion requires companies to draw upon a broad range of capabilities. R&D is important, but it is just one piece of the **innovation puzzle**. To meet the requirements of quality, affordability and access, companies should be prepared to rethink their entire business and operating models. They should build new relationships with stakeholders across the supply chain, seek out new distribution channels, and develop an intense focus on operational excellence to bring down costs and increase efficiency…Slightly more than one-third of respondents to our survey say that they are already reaping rewards from a more **"frugal" approach to innovation**, while a further 40% plan to do so. [416]

Frugal innovation responds to limitations in resources, whether financial, material or institutional, and turns these constraints into an advantage. Through minimizing the use of resources in development, production and delivery, or by leveraging them in new ways, frugal innovation results in dramatically lower–cost products and services. Successful frugal innovations are not only lower in cost, but outperform the alternative, and can be made available at large scale. Often, but not always, frugal innovations have an explicitly social mission. [76]

Parameter	Frugal Innovation	Standard Innovation
Environment	Institutional voids and resource constraints	High quality institutions and slack resources
Cost	Low cost input and Low cost output	High cost input and High cost output
Diffusion Approach	Bottom up approach	Top down approach
Users	Late Majority, Laggards: Low income, limited education	Innovators, Early adopters: High income, high education
Sources	Entrepreneurs, Family Business Groups, Social Movements	Entrepreneurs, Large organizations
Process	Open, Distributed	Closed
Characteristics	Primarily Architectural	Primarily Component

Table 15.1: Comparison of Frugal and Standard Innovation

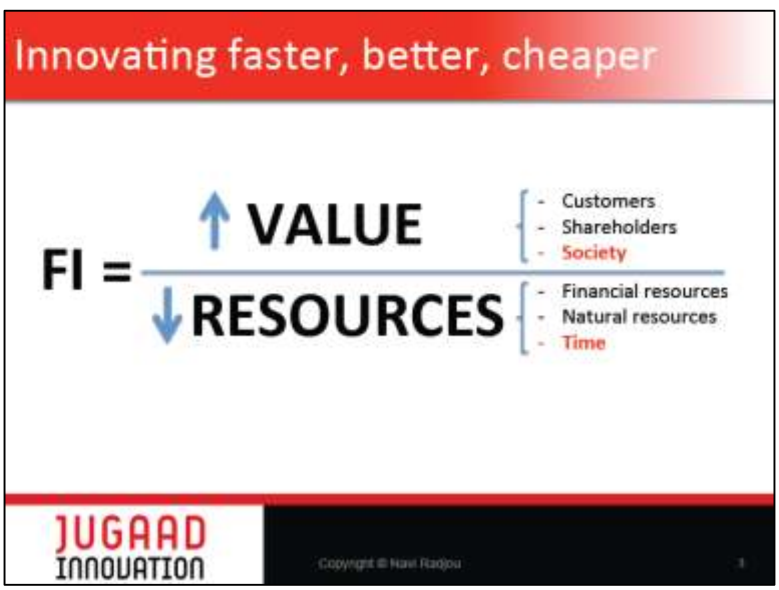


Fig. 15.1: Frugal Innovation Equation [451]

Frugal does not mean a poor-quality, off-the-mark, improvised solution; often sold as a "Jugaad" product. Frugal innovations show that the sophistication of a solution is not by default rooted in the newest technology but in a comfortable, robust, and affordable solution capable to uplift the standard of living to the next better level… India's enormously young population with limited budgets and high consumption aspirations provide an ideal experiment ground for many firms. Not surprisingly, **India has emerged as a vibrant and versatile source for frugal innovations**. Frugal innovations do not relate to hardware innovation alone and **often encompass the whole spectrum of product, process, marketing and organizational innovations**. [467]

In a world with microchip implants, car-to-car communication, and talk of drone delivery services, it can seem as if innovation is becoming increasingly high-tech. But what about the world's poorest, for whom such gadgets are out of reach? What types of innovation would be most beneficial for them? **Technology alone will never solve the complex problems faced by the world's poorest people**. These questions are the **driving force behind efforts in "frugal innovation"** — designing products specifically to meet the needs of the world's poorest people. The concept challenges innovators to do more with less. In general, the creators of frugal innovations strive for them to be **affordable, sustainable, lightweight and rugged**. [468]

Dr. Pasha Mahmood, Professor, IMD stated that "Today, emerging markets account for 36% of the global GDP. Some estimates indicate they will represent a US$30 trillion opportunity by 2025... Most MNCs are currently doing a poor job exploiting these opportunities and earn just 17% of their total revenue from these markets…Frugal innovation is much more than designing a cheaper version of an existing product. It requires a whole new mindset." [469]

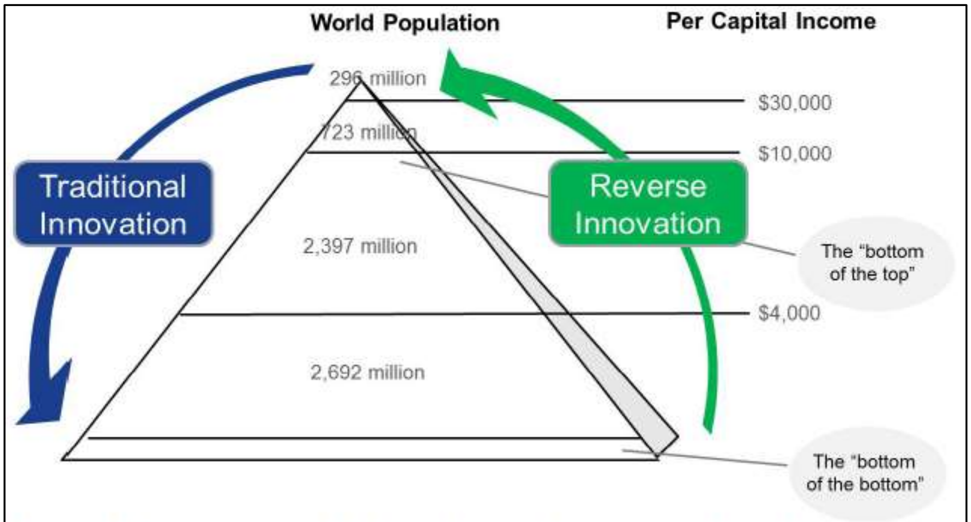


Figure 1: Frugal innovation targets the bottom and middle of the local market (*Source: P.I. Mahmoud*)

Fig. 15.2: Frugal innovation targets the bottom and middle of the local market [469]

15.3. Frugal Innovation: World Wide Efforts

Throughout the world many universities have established separate Frugal Innovation centers. **Several US universities** have programs that develop frugal solutions. Such efforts include the **Frugal Innovation Lab at Santa Clara University** and a two **quarter project course at Stanford University**, the Entrepreneurial Design for Extreme Affordability program. [81]

The Innovations of students of Santa Clara University USA are listed at the website. Few of them are

- Energy Made in Uganda
- Lab on a Chip
- Dynamic Poverty Heat Map
- Electrochemical Detection of Arsenic
- Mobile Forum for Education
- Quick Chill etc. [447]

Fig. 15.3: Santa Clara University USA: Frugal Innovation Lab [447]

Nanyang University Singapore Frugal Innovation Lab assembles cross-disciplinary teams of NUS students for 13 weeks to solve real world problems. Teams must design and prototype solutions for validated emerging market challenges. Frugal Innovation Lab is a unique action-learning experience that assembles cross-disciplinary teams of undergraduate, graduate and Ph.D. students from the Faculty of Engineering, School of Business and across NUS into focused projects. The objective of the projects is to build solutions for specific pre-selected problems in the emerging Asian markets such as India and Indonesia. The intent is to create sustainable companies if a solution can be developed and demonstrated. Frugal Innovation Lab is an extremely rare opportunity to apply your creativity, passion for solving problems and channel it into a new company that can create jobs in the region! If you are a hands-on engineer who likes to build things or a business student who is interested in impacting the world in a big way, this Lab is for you. This course is NOT about how to write a business plan or create a presentation to a VC. It's about applying your creativity and pulling together technologies in a unique way that solves an outstanding specific problem that can jumpstart a new business. [452]

Fig. 15.4: Nanyang University Singapore Frugal Innovation Lab [452]

IBM has started a Lab in Nairobi for "Frugal Innovation". IMB Research has 12 global research facilities but it just opened its first one in Africa, in Nairobi, Kenya. At the head of the lab, Dr. Osamuyimen Stewart is an IBM artificial intelligence researcher from New York. In an interview for Stanford University, he described the activities of the new lab as being "frugal innovation". [453]

The Centre for Frugal Innovation in Africa investigates how frugal innovation can contribute to inclusive growth and transformation in Africa. It is one of the joint multidisciplinary centres of Leiden University, Delft University of Technology and Erasmus University Rotterdam in the Netherlands. [454]

Fig. 15.5: Centre for Frugal Innovation in Africa by 3 Universities of Netherlands namely Leiden University, Delft University of Technology and Erasmus University Rotterdam [454]

15.4. Frugal Innovation: India's New Paradigms of Innovation

Innovation is a notoriously difficult word to define and our usage has been shaped by those we interviewed. **Innovation in the Indian context is something quite unusual.** General Electric conducts an annual survey called the "GE Global Innovation Barometer" which benchmarks Indian corporate attitudes to innovation against those of their counterparts across the world. India sees innovation more with as **"implementation" than "invention"** which supports our view that **India is currently mid-way through the evolution of its innovation capabilities**. [31]

India's enormous domestic market means low-margin models of commercialization can still be profitable. Corporates will increasingly innovate for the Indian mass market leveraging that opportunity for subsequent export. [31]

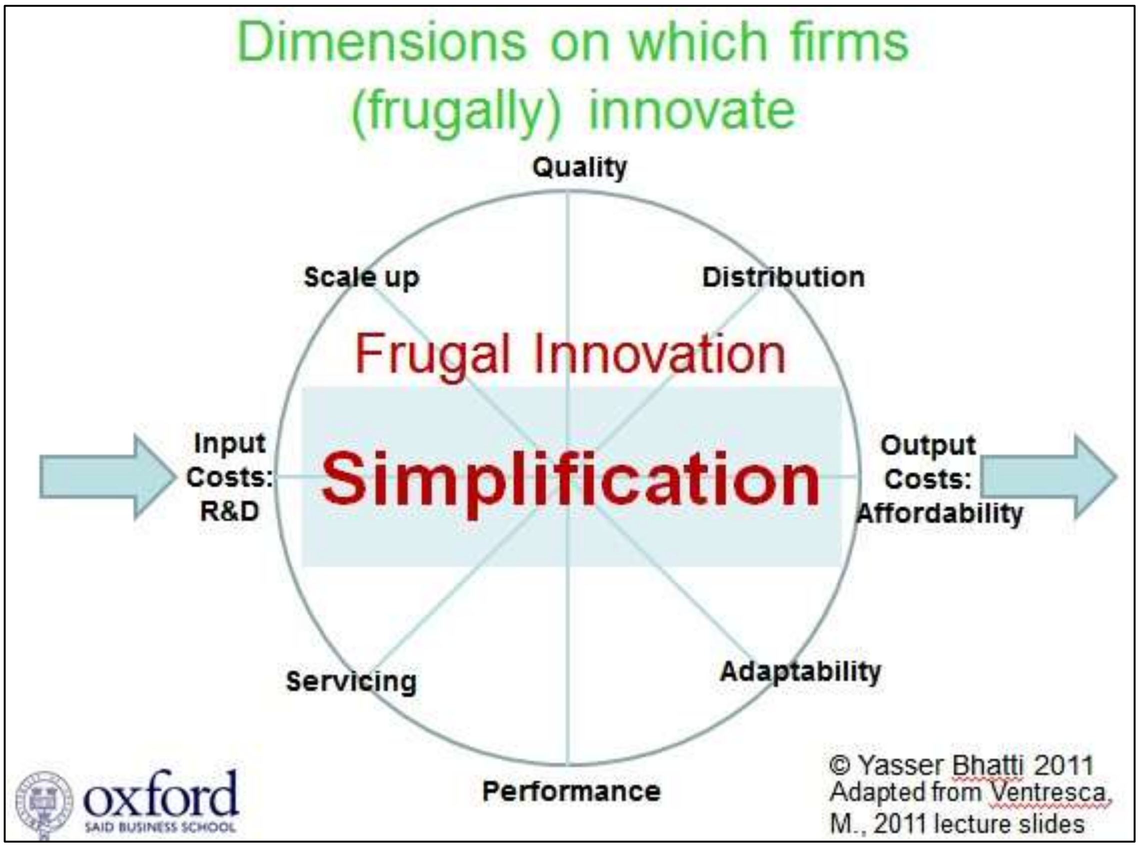


Fig. 15.6: Dimensions on which firms Frugally Innovate [446]

The big markets of tomorrow are located in large developing economies like India. Customers in these economies, whether businesses or consumers, are resource-constrained and, hence, affordability is an important criterion for product success. Companies addressing these markets have no option but to reduce the upfront costs of development as well as the direct cost involved in the production and delivery of products. A **paradigm of frugal innovation** has emerged to guide this process. [83]

The term **'Frugal Innovation'** has come from the direct English translation of a Hindi word **'Jugaad'** which basically stands for an spontaneous arrangement of a product thereby reducing the complexity and cost of production of goods for making affordable and economical and is mainly driven by lack of resources. Frugal Innovation or Frugal Engineering is widely exercised in India and other developing nations. The sweeping revolution for luxurious and unaffordable items provided the driving force to the local people of the developing nations to design and deliver such items that are not only cost effective but also raised the social capital. [84]

Siemens, the German industrial giant, is also leveraging the jugaad mindset of its R&D groups in India and China to develop frugal solutions that deliver higher value to customers. For instance, Siemens' Indian engineers—in close collaboration with their German peers—have developed a Fetal Heart Monitor that uses inexpensive microphone technology rather than costly ultrasound technology. This affordable Fetal Heart Monitor is part of Siemens' larger portfolio of frugal solutions labelled SMART (Simple, Maintenance-friendly, Affordable, Reliable, and Timely-to-market). SMART products are 40-60 percent cheaper than high-end solutions. They are also energy-efficient as well as quicker and easier to implement, use, and maintain. Siemens estimates there is a US$200 billion global market for SMART products. As Peter Löscher, CEO of Siemens, affirms: "Scarcity of resources is not an impediment but an enabler (of innovation)." [85]

Figure 9: The innovative models offer much greater affordability compared to their peers

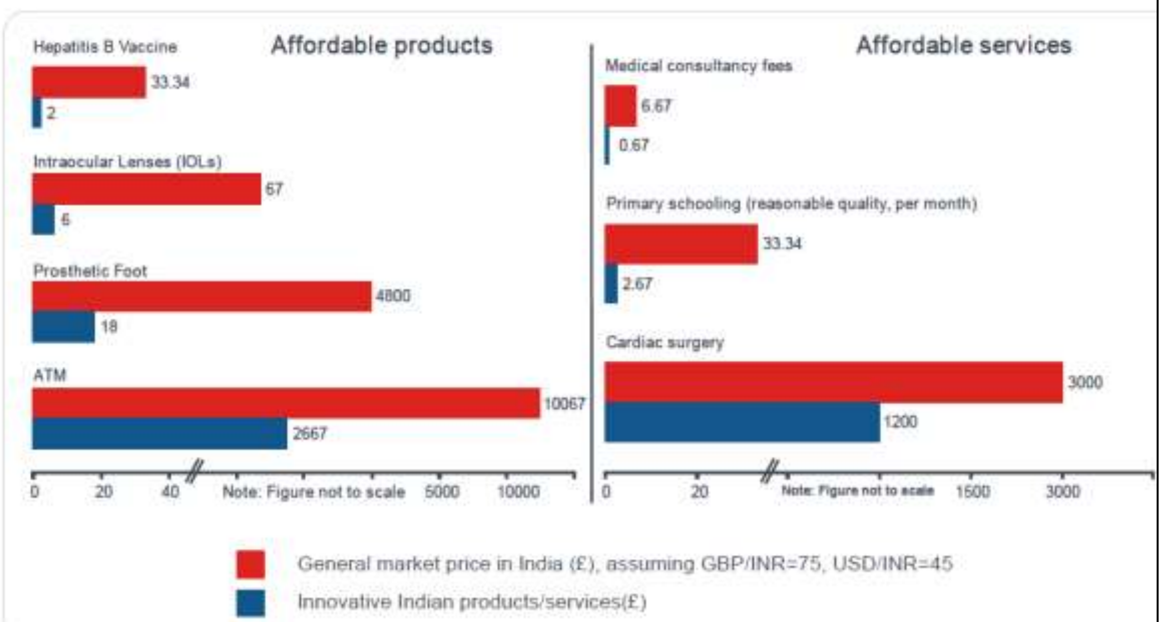


Fig. 15.7: Frugal Innovation: Indian product & Services are affordable [473]

From the 12th Plan Approach Paper: "Innovation is already contributing significantly to the growth of the economy and dynamism of industry. Indian entrepreneurs are developing novel solutions for the needs of Indian consumers that provide access to services and products at a fraction of the cost of solutions available from industrially advanced countries." For Examples:

- India has the cheapest phone calls in the world
- Extremely low cost eye surgeries ($50) which don't compromise on Surgical standards

- A low-cost vaccine for Hepatitis B
- A people's car - the Tata Nano for less than $2,500
- A refrigerator using thermo---electric cooling for less than $75
- A water purifier combining Nano-technology and rice husks to provide safe drinking water for a family of 5 at $0.02 per day
- A solar lighting system for rural houses at $200
- A solar powered ATM that uses 4.0 per cent of the energy of conventional ATMS [31]

Three distinctions of the emerging Indian approach to innovation are worth noting.

- Firstly, it focuses on finding **affordable solutions** for the needs of people– for health, water, transport etc. – without compromising quality.
- Secondly, in this Indian approach to innovation, desired outcomes produced by innovations in organizational and process models that the limited people the benefits of technologies that may be developed in scientific laboratories.
- Thirdly, there are renovations in the process of innovation itself to reduce the cost of developing the innovations.

An example is the open source drug discovery process being applied by the CSIR to develop drugs for treatment of tuberculosis, based on a semantic search, web---based platform for collaboration developed by synthesis, an innovative approach that has cut down the costs and reduce the time and drug development. [31]

This **new paradigms of innovation**, focused on reducing **frugal costs solutions with frugal costs of innovation**, in which **India may be emerging as a global leader**, contrasts sharply with the conventional approach, mostly focus on increasing inputs of science and technology and research and development and measurement of the numbers of papers and patents produced. **Frugal innovation is focused on the efficiency of innovation and outcomes that benefit people, especially the poor**. Industrially advanced countries too are examining their innovation policies to incorporate this broader concept of innovation. For instance,

- **Sweden, ranked as the 2nd most innovative nation in the world in terms of traditional inputs of Science and Technology and Research and Development per capita**, is formulating a National Innovation Strategy that is focused on using innovation and not only enhancing growth and competitiveness of its industries, but also that addressing global challenges of inclusion, and for improving the delivery of its public services. Its national strategy broadens the scope of innovation to go beyond products and processes, services and new business models.
- Similarly, the UK has also placed all types of innovation at the heart of its strategy to drive future growth and the country's vision. Its strategy also highlights the need for government policy to recognize the changing face of innovation. Thus the metrics of immigration are shifting from them input oriented paradigm focused on R&D investments and patents, towards an output oriented system that looks at impact in terms of benefits for people. [31]

Whilst innovation in India has been associated with **jugaad** (street-innovation) it is surprisingly recently that corporates, industry organizations, institutions and the Government have **started to take it seriously**.

In Indian, the innovation is not a new term. We adopt localized innovative solution namely "Jugaad". One should read two books on this issue Books namely

- "From Jugaad to Innovation" and
- "8 Steps to Innovation: Going from Jugaad to Excellence"

By Prof. Rishikesha T. Krishnan, IIM Bangalore

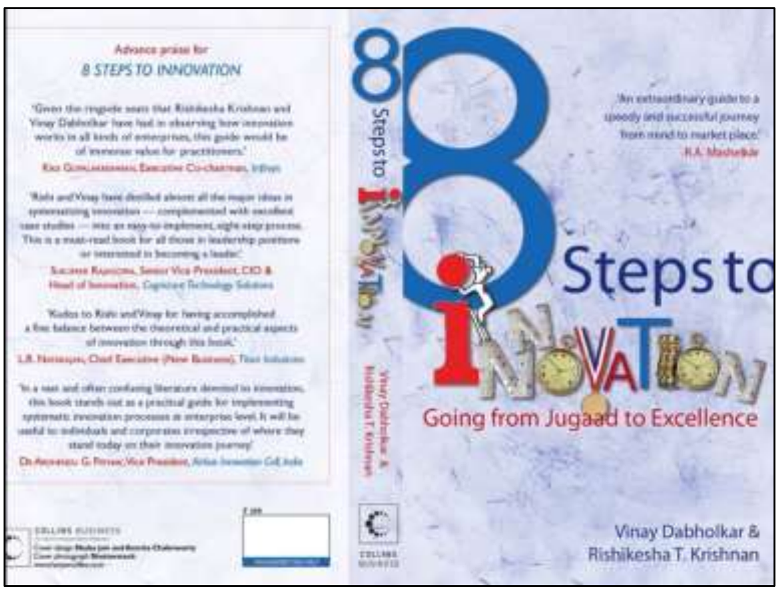


Fig. 15.8: Prof. Rishikesha T. Krishnan, IIM Bangalore Books "From Jugaad to Innovation" and "8 Steps to Innovation: Going from Jugaad to Excellence" [49]

As per NESTA, UK Report 2012 (94 pages), "A number of factors align to create the conditions for high–impact frugal innovation in India: [76]

1. A culture of 'jugaad,' or creative improvisation, means the unusual skillset and mindset required for frugal innovation are abundant.

2. A huge market with a growing, aspirational middle class creates the perfect conditions for frugal innovation.
3. Not only is the Indian consumer base growing, but it is also extremely price–sensitive and willing to experiment, sustaining demand for frugal innovation.
4. Extreme conditions and major gaps in service provision stimulate demand for low-cost solutions in health, education and energy.
5. Strengths in service and business model innovation create an advantage in creative remodeling of product-service ecosystems.
6. New sources of social finance are lowering the cost of investing in frugal innovations.
7. An increasingly 'inclusive' science and innovation policy is prioritizing getting 'more for less for more' and attempting to develop the institutional conditions that could drive high impact frugal innovations." [76]

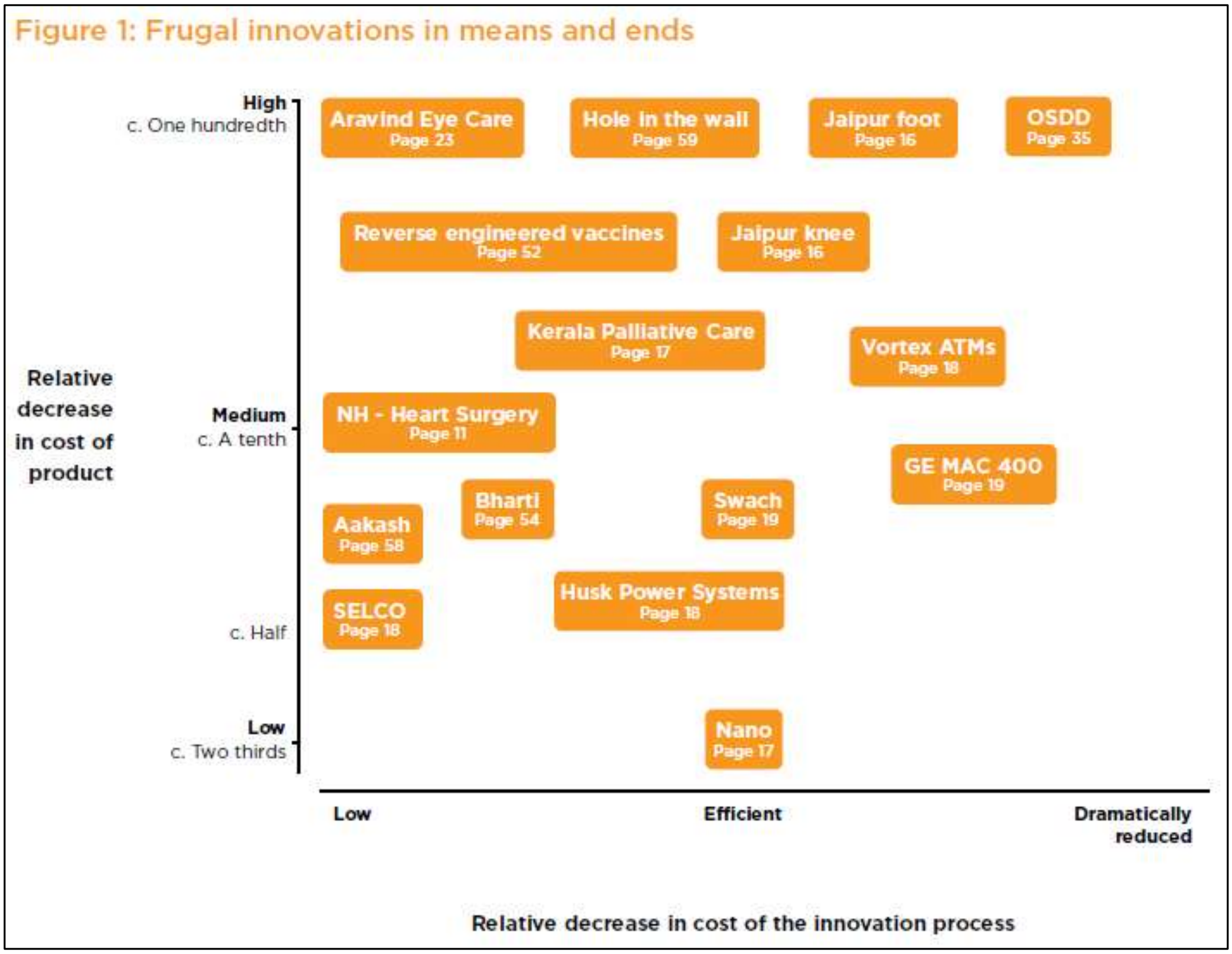


Fig. 15.9: Frugal India Innovation [76]

Carlos Ghosn, Chairman and CEO of the Renault-Nissan Alliance, famously coined the term "**frugal engineering**" in 2006. He was impressed by Indian engineers' ability to innovate cost-effectively and quickly under severe resource constraints. And under Ghosn's leadership , Renault-Nissan has proactively embraced frugal engineering and become one of the world's leading producers of both electric cars as well as low-cost vehicles — two of the fastest growing and most promising market segments in the global automotive sector. [455]

Frugal innovation or **frugal engineering** is the process of reducing the complexity and cost of a good and its production. Usually this refers to removing nonessential features from a durable good, such as a car or phone, in order to sell it in developing countries. Designing products for such countries may also call for an increase in durability and, when selling the products, reliance on unconventional distributions channels. Sold to so-called "overlooked consumers", firms hope volume will offset razor-thin profit margins. Globalization and rising incomes in developing countries may also drive frugal innovation. Such services and products need not be of inferior quality but must be provided cheaply. [81]

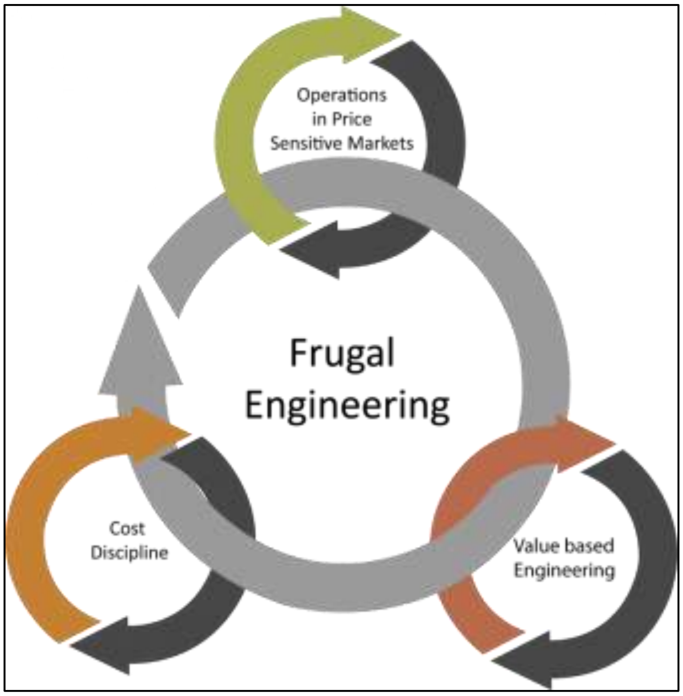


Fig. 15.10: Frugal Engineering [88]

15.5. Examples of Frugal Innovations in India

India's rural innovators have proved that ordinary people are indeed capable of extraordinary inventions. Despite many constraints - lack of education and severe cash crunch - most of them have succeeded in using technology cost-effectively to build ingenious products.

In February 2000, the Government of India has setup National Innovation Foundation (NIF), a grant-in-aid institute under the Department of Science and Technology (DST).The mission of NIF is to make India a global leader in sustainable technologies by building upon genius of grassroots technological innovators and traditional knowledge holders. Let's see few interesting examples.

15.5.1. Tata Swach: World's Cheapest Water Filter

Tata Swach, potentially the world's cheapest water filter Tata group, whose filter Swach produces enough potable water to last 200 days for an average family of five. It uses paddy husk ash and silver particles to kill 80% of bacteria that cause waterborne diseases.

Fig. 15.11: Tata Swach: World's Cheapest Water Filter [86]

15.5.2. Param Super Computers

PARAM is a series of supercomputers designed and assembled by the Centre for Development of Advanced Computing (C-DAC) in Pune, India. The latest machine in the series is the PARAM Yuva II. [210]

Fig. 15.12: Param Super Computer [210]

15.5.3. Mumbai Dabbawala

The now-famous “Dabbawala” (literally, lunchbox-carrier) system is an innovative business process that allows 4,500–5,000 semiliterate Dabbawalas to deliver almost 200,000 lunches to workers every day in Mumbai. The Dabbawalas reportedly make one mistake per 6 million deliveries. So remarkable is this delivery network that international business schools have studied the work flows of the Dabbawala system to understand the key to its stellar performance rating. [208]

Fig. 15.13: Mumbai Dabbawala [208]

15.5.4. Low Cost Incubator

Low-cost incubator, or infant warmer. Premature babies are kept in these cribs to regulate body temperature. A traditional incubator costs up to Rs 1 lakh. Dr Sathya Jeganathan, a pediatrician in Chengalpattu, Tamil Nadu, came up with the idea of a cheaper, easyto-maintain warmer after the state government failed to supply incubators on time

Fig. 15.14: Low-cost incubator by Dr. Sathya Jeganathan, a pediatrician in Chengalpattu, Tamil Nadu [86]

15.5.5. Chotukool

Chotukool is an innovative approach to tackling the problem of food storage in India, a country in which around one-third of all food spoils and an estimated 80 percent of households do not have access to or use a refrigerator. Chotukool is the brainchild of Gopalan Sunderraman, Executive Vice President of Godrej & Boyce Manufacturing, a 100 year-old company based in Mumbai, India. An example of the power of frugal innovation, Chotukool is a groundbreaking product on many levels – in terms of the technology used, its design and the business model employed to develop and deploy it. Chotukool is a 45-liter plastic container that can cool food to around 8 to 10 degrees on a 12-volt battery. Abandoning the compressor technology used in domestic fridges, it uses a thermoelectric or solid state cooling system. It does not have a front opening door but opens from the top to ensure that the maximum amount of cool air remains in the container when opened.

Fig. 15.15: Chotukool [89]

15.5.6. Health Monitor

Frugal Digital also developed Clock Sense, a monitor converted from an old alarm clock which can easily assess temperature, pressure, pulse, oxygen saturation, respiration rate, blood sugar. It is cheap to produce and can be assembled from components which are easy to find across India. The indicator provides simple information: red means the patient should be taken to the hospital immediately, yellow indicates that an appointment with a doctor should be made, green indicates good health.

Fig. 15.16: Health Monitor [82]

15.5.7. Toxic Check

Another best Innovators under 35 published by the prestigious American magazine, Technology Review in 2012.

How many times have you worried about toxins in your food? And what if you had a magic stick that could do a quick check for toxins before you eat or drink. Priyanka Sharma's "plastic biochip electro-chemical sensor" may well pave the way for such easy-to-use pollutant detectors that will help monitor harmful molecules. Priyanka Sharma with her biochip sensor Priyanka Sharma and her biochip sensor "Due to the severe toxicity of pesticides even at trace levels, it is essential to monitor their levels in the environment, especially in food items," says this 28-year-old postgraduate student of environmental science. "The biochips available in the market are usually very costly and give false positive results due to poor sensitivity." Ms Sharma used an ultra-thin layer of gold - "a very good electro-active compound" - on plastic sheets that were then laser-cut to demarcate the electrodes. Thus was born the portable biochip sensor - 7.6cm x 2.54cm (3in x 1in). Priced at five rupees ($.09; £.06), the sensor could revolutionise the monitoring of pesticides in food. It could spell the end of the bulky instruments and complex, time-consuming testing that come with conventional systems. [545]

15.5.8. Stair Climbing Wheelchair

Traditional wheelchairs cannot be used on architectural barriers, such as stairs, thereby restricting the movements of specially-abled people. Vardaan, a brainchild of IIT Kanpur’s Shanu Sharma, facilitates climbing up and down the stairs by using an innovative ‘Y’-shaped wheel that provides better grip and optimum braking along with a ratchet and a braking system.

Fig. 15.17: Stair Climbing Wheelchair by Mr. Shanu Sharma, IIT Kanpur [91]

15.5.9. Tsunami Warning System

This team has devised a new technique for providing Tsunami forecasting. Accurate forecasting of Tsunami can be very vital in issuing warnings and evacuating people, given that the Indian plate continues to collide with the Eurasian plate, and we have witnessed various Earthquakes impacting us from places as far as Indonesia.

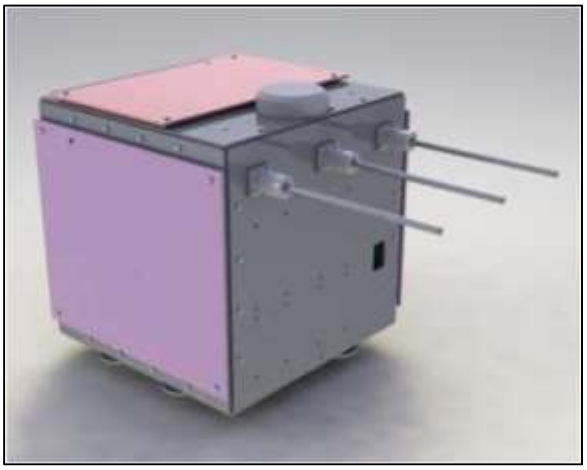


Fig. 15.18: Ionospheric Measurement-based Tsunami Warning System Innovated by: Jhonny Jha, Sanyam Mulay, Deepika Thakur, Husain Manasawala and Tushar Jadhav, IIT Bombay [91]

15.5.10. Vegetable Dyes for Wooden Toys

C V Raju has revived the dying art of making wooden toys among the craft community in Etikopakka. After 1910 the craftsmen had resorted to titanium oxide bonded synthetic colors for making wooden toys. Raju's key strategy has been to strengthen the traditional local knowledge of making vegetative dyes, develop new tools, techniques and methods for increasing shelf life of the dyes and generate new uses. Raju's experiments have resulted in many new toys imparted with vegetable dyes for which market is slowly emerging in India and abroad.

Fig. 15.19: Vegetable Dyes for Wooden Toys CV Raju Andhra Pradesh [80]

15.5.11. Affordable Prosthetics

Indian prosthetics organization, BMVSS, say they can produce an artificial limb for as little as $45. This compares to upwards of $10,000 dollars for a similar procedure in the U.S. Thousands of Indian amputees who would otherwise be unable to afford expensive medical procedures have benefited from BMVSS and their "Jaipur Foot" program since it was established in 1975.

Fig. 15.20: Affordable prosthetics BMVSS [82]

15.5.12. Solar Mosquito Destroyer

This device makes use of the smell from the septic tank to attract the mosquitoes, which get trapped in the device. Heat builds up inside the device as a result of direct sunlight exposure. The trapped mosquitoes, thus, get killed due to the accumulated heat. He has commercialized his product, on a small scale and will love to have partners who will scale it up. The innovator has also developed house fly trap.

Fig. 15.21: Solar Mosquito Destroyer Mathews K Mathew Kerala [80]

15.5.13. Washing-cum-Exercise Machine

All those who wash clothes by hand have often wished for a washing machine that is cheap. But then, frequent power cuts (particularly in the rural regions) would make it difficult for one to use even a low-cost electric washing machine. Remya Jose, then a class 11 student, thought of a simple, ingenious solution. She developed a washing machine which does more than just wash clothes. It even provides its users the chance to shed a few kilos!

Fig. 15.22: Washing-cum-Exercise Machine Remya Jose Kerala [80]

15.5.14. Automatic Food Making Machine

Who has not wished a machine, which would cook one's chosen recipe every time exactly as one wished it to be? But then such a machine will not elude us any more, if Abhishek's innovative food machine comes in the market. This is a tested gadget with boxes in it to hold different ingredients and a display screen from which one can select options to cook different items.

Fig. 15.23: Automatic Food Making Machine Abhishek Bhagat Bihar [80]

15.5.15. Low-Cost Incubator for Babies

Dr. S. R. Daga, formerly a pediatrician at Cama Hospital Mumbai, India, has developed a low-cost incubator from polystyrene boxes for preventing hypothermia among babies.

Fig. 15.24: Low-Cost Incubator for Babies [97] [105]

15.5.16. Mobile Phone Projector

Frugal Digital has often developed products in India from mobile devices: it used a 3G smartphone to create a battery-powered projector, using locally-sourced components, for use in remote schools. Insert a memory stick to the USB in FD's Darshana device and you've got a cheap, durable AV teaching aid. The projector has data connectivity, and the touchscreen of the phone can be used as a track pad.

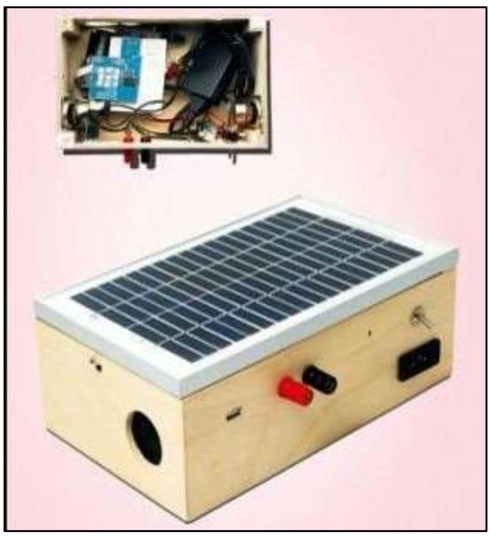


Fig. 15.25: Mobile Phone Projector [97] [107]

15.5.17. Jaipur Foot Prosthetics

Today over 20,000 individuals each year receive a free "Jaipur foot". Designed in and named after Jaipur, India, the prosthetic leg was designed to be inexpensive, water-resistant, and quick to fit and manufacture. The Jaipur Foot is made of polyurethane, which at the time was the new material used in the production of the prostheses. The material increases the durability and the convenience of use. Now the government of India supports Bhagwan Mahavir Viklang Sahyata Samiti with financial aid to carry out the work done by the organization. The Jaipur Foot has helped many people to overcome their leg disability… the non-governmental organization Bhagwan Mahaveer Viklang Sahayata Samiti has collaborated with **Stanford University** to jointly develop the $20 Jaipur knee, stated by **Time magazine** as one of the **best 50 inventions in the world in 2009**. [449] [450] [466]

Fig. 15.26: Jaipur Foot [449] [487]

15.5.18. Hepatitis B Vaccine

Frugally innovated products extensively occur in every sector, one such sector is Biotechnology. Recently, an Indian biotech giant invented Hepatitis B vaccine which is much cheaper than the existing drugs, bringing down the price from $15 per injection to about 10 cents. [456]

15.5.19. Aakash Tablet

Some best examples of frugal innovations include Aakash tablet, Indian government made this innovative product available to the every student of the country at the subsidized rates to access the digital world. [456]

Fig. 15.27. Aakash Tablet [458]

15.5.20. General Electric's Portable ECG Machine

Another innovative example comes from the R&D giant General Electric's (GE) Mac 400 which is a portable ECG machine, remarkably reduced to its essential functions and capable of running on batteries. It is particularly designed to make it easier to carry out medical diagnoses in rural areas of the country. The ECG is the most widely performed cardiac test in the developed world, and GE Healthcare is the market leader. An ECG machine costs about $5,000 and a scan about $20. This complex equipment is heavy and bulky, and requires a skilled technician to operate it, as well as elaborate service support. In other words, GE’s premium ECG machines were nonstarters in rural India, because patients didn’t have the money to pay for the test and small clinics and physicians couldn’t afford the machine or the support costs. The MAC 400 costs $800, instead of $2,000 for a conventional ECG machine, and reduced the cost of an ECG to just $1 (50 rupees) per patient. A newer version from GE reduces the cost to just 10 rupees per scan. [456] [457] [458]

15.5.21. Vortex ATM Machine: Solar Powered and Energy Efficient

Vortex Engineering Private Limited (“Vortex”) is a company headquartered in Chennai in the Southern Indian state of Tamil Nadu. It was set-up in 2001 as an incubation project of the Indian Institute of Technology Madras (IIT-M). The company develops and manufactures Automated Teller Machines (ATMs) that are “highly reliable, rugged, easy to use and eco-friendly”. The solutions are specially designed to suit conditions prevalent in rural and semi-urban areas, e.g. unreliable power supply and higher illiteracy levels of end users. Vortex ATMs have an in-built fingerprint identification system so that the user does not need to key in a personal identification number, a feature that has apparently proved very popular in rural areas. The cash machine (ATM) which Kannan and his colleagues in Chennai developed is remarkable. With the lowest power consumption in the world – up to 90% less than conventional alternatives – it can run on solar power. Moreover it costs just one-third of conventional ATMs, despite having sophisticated inbuilt fingerprint scanning which allows even illiterate farmers to access the formal banking system. It holds out the prospect of bringing basic banking services within reach of rural India, most of which is far from the electricity grid. It is already being taken up by the State Bank of India and others, and Kannan hopes to see 3,000 installed by the end of 2013. [459] [474]

Fig. 15.28: ATM Machine [459]

15.5.22. Application Based on India's "Missed Call Culture"

Google India's Managing Director Rajan Anandan called "**India's missed call culture**" a "**massive phenomenon**" at an event on Monday night organized by the group Geeks on a Plane Delhi…. According to a study from the Learning Initiatives on Reforms for Network Economies (LIRNE) a couple of years ago, **over half of Indian cellular subscribers made missed calls to convey a message**… What do you think? Are you using missed calls for an ad-hoc low-cost messaging system? [465]

Missed calls are being incorporated into mobile apps and services as a standard type of messaging like a text or an answered call itself. For example, an Indian cloud telephony service provider startup called KooKoo has been working with a Bangalore-based company to create an information market based around missed calls. If you want to know the latest weather, the latest Groupon-style deal, or the real-time bus schedule, you can send a missed call to the designated number and get an automated or manual voice call back with the answers you need. [465]

15.5.23. Best Load Carrier for Manual Labor Ever Created

Vikram Dinubhai Panchal of The National Institute of Design (NID), created this masterpiece and priced it at a miniscule cost of Rs. 300. [471]

Fig. 15.29: National Institute of Design: Load Carrier [471]

15.5.24. Remote Controlled System for Power Tillers

Prajwal Kumar's awesome invention won the British High Commission's "Best Electronic Product Award (Agriculture)" for 2010. Remote Controlled System for power tillers was basically developed for making the works of farming easier and more comfortable. This system is an electronics combined mechanical gadget which goes as an attachment for power tillers. This new technology which was developed around the year 2005, after prolonged testing and field trials, has now achieved a big success to go for production with great demand from all over India. Innovation is being protected by filing 2 patents in the name of the innovator. [471] [472]

Fig. 15.30: Remote Controlled System for Power Tillers [471] [472]

15.5.25. Preventing Driving Without a License/Valid Documents by 10th Standard Student Varsha Kumari from Patna Bihar

In the wake of increased rate of accidents caused by those without licenses, or without proper training; these young minds have conceived novel ideas to prevent this. The basic idea is to prevent a vehicle from being driven if the authorized license is not present, is invalid or has expired. Varsha's innovation is about swiping the driving license, like on a credit card machine. The vehicle starts only if a pre-authorized license is swiped. This also protects the car against theft. The idea came to her when a friend's car was stolen and never found. [504]

Durgesh's (10th standard student of Begusarai, Bihar) innovation has a mini scanner fixed on the steering wheel, only up on the drivers' license matches with the authentic license stored in the scanner's database, the steering wheel gets unlocked. [504]

15.5.26. Shoes that See

I would like to quote one of the best Innovators under 35 published by the prestigious American magazine, Technology Review in 2012.

Visually impaired people suffer greatly when it comes to mobility - having to depend on someone for directions or to alert them to obstacles. Even a walking stick can only be of limited help. So how about a shoe that can help them go places? That was the question that inspired engineer Anirudh Sharma, 24, to develop "Le Chal – Hindi" for Take Me Along. It is a low-cost shoe that doubles as a navigation aid with four embedded vibrators: in the front, back and on either side. Le Chal works via a mobile phone which has GPS (Global Positioning System) and Google Maps. You tell your destination to the smart phone, which then uses Bluetooth to communicate with a circuit board in the heel of the shoe. The user then gets a poke in the direction to turn. Mr. Sharma is now looking for a shoemaker who will help him produce shoes, loaded with the Le Chal kit, that will cost less than 1,600 rupees ($30; £18.60) a pair. [545]

Fig. 15.31: Le Chal – Hindi for Visually impaired people [545]

15.6. Frugal Innovations in Rural Sector of India

15.6.1. Mechanical Tree Climber

D. Renganathan developed a mechanical tree climber which can be used for scaling palm and coconut trees. Climbing trees for harvest is difficult and dangerous work -- the tree climber designed by Renganathan uses a 'four-lock pin' system to prevent falls. The device now sells across south Asia.

Fig. 15.32: Mechanical Tree Climber by D. Renganathan [82]

15.6.2. A Retrofitted Cycle

A retrofitted cycle that goes faster on cratered roads. Kanak Das of Morigaon, a village in Assam, caught the attention of an IIM professor, who helped patent the device. MIT trying to apply Das's innovation to automobiles.

Fig. 15.33: A Retrofitted Cycle by Kanak Das of Morigaon, a village in Assam [86]

15.6.3. Mitti-Cool-Village Fridge

The Mitti-Cool Fridge was developed and launched by Indian engineer, Mansukhbhai Prajapati, in 2006. Made entirely from clay, the device costs roughly $50 and uses no electrical power. It can keep items of food fresh for up to five days and has been a valuable addition to rural communities in India. Mansukh Prajapati, a former tea-shop-owner-turned-entrepreneur, who was inspired by a newspaper headline that described a matka, or an earthen pot, as a fridge. Used the concept of the cooling effect of evaporation to make an earthen refrigerator. Created a new industrial process for working with clay. [82] [86]

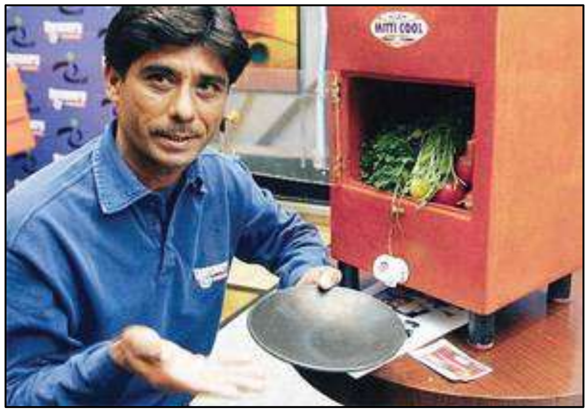


Fig. 15.34: Mitti-Cool-Village Fridge by Mansukhbhai Prajapati [82] [86]

15.6.4. Reaper Windrower Machine

Many times, in a standing crop, soybean pods shatter due to non-availability of laborers for harvesting the crop in time, leading to reduced yield and loss. To solve this problem Bhagwan Singh decided to develop a reaper windrower machine. This device has three different units namely, cutting unit, which consists of cutter bar, reel unit for pushing the standing crop towards the cutter bar and gathering unit to windrow the crop at centre of the machine thus making it easy to handle/transport to the threshing floor. It reduces manpower requirement and the drudgery involved in the harvesting process. The machine has 7 feet width of operation and can cover 0.4 hectares per hour. While operating this machine, fuel consumption of tractor is 2.5-3 liters per hour. [80]

Fig. 15.35: Reaper Windrower Machine by Bhagwan Singh Madhya Pradesh [80]

15.6.5. Bamboo Windmill

Mehtar Hussain and Mushtaq Ahmed from Assam built a bamboo windmill for around $100 to pump water from a small paddy field. The invention has now been adopted by Gujarati salt workers, who are some of the poorest people in the state, to pump brine water. Petrol-powered pumps consume huge amounts of fuel, at a cost of around $1,000 each year. The wind-powered pump runs at a fraction of the cost.

Fig. 15.36: Bamboo Windmill by Mehtar Hussain and Mushtaq Ahmed Assam [82]

15.6.6. Bullock Operated Sprayer

The bullock operated sprayer is pulled by a pair of bullocks and gets the drive from the ground through a gear box and belt pulley system. When the operator shifts the lever to a higher gear, the frequency of strokes of the pump increases as a result of which more pressure develops in the container. The spray fluid, thus, atomizes into fine droplets with a wider swath. This sprayer considerably reduces time requirement as compared to manual spraying and also the drudgery and health hazards involved in manual spraying. It has 18 nozzles, spaced at a distance of 35 cm and can cover 3.5 acre/h. [97] [106]

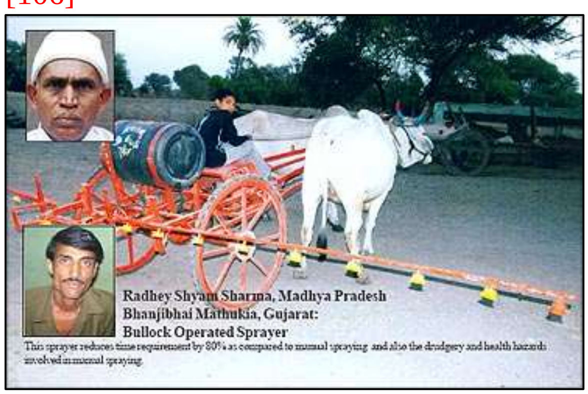


Fig. 15.37: Bullock Operated Sprayer by Radhey Shyam Sharma Madhya Pradesh [80] [97] [106]

15.6.7. Lemon Cutter

A small workshop owner from Uslampathy village in Tamilnadu, M Nagarajan has developed an innovative technology for cutting lime into small pieces in bulk quantity. This technology offers a great value proposition for the pickle manufacturing companies. The pickle industry suffers with a big problem of inefficiency in its operations due to low degree of atomization e.g. cutting of fruits is done manually. The second big problem, the industry faces is short-supply of labor during peak seasons, which limits the capacity. It is a novel machine in terms of its cost effectiveness, efficiency, drudgery reduction for women, safety considerations and transmission system.

Fig. 15.38: Lemon Cutter by M. Nagarajan Tamilnadu [80]

15.6.8. Bamboo Splint-Making Machine

Paresh Panchal's bamboo splint-making machine makes it possible for people in isolated villages to make incense sticks at low cost. Bamboo splint-making has been done manually for years using knives, which can be tedious, time-consuming and risky. The machine was awarded at the 7th annual presidential grassroots innovation awards in March, 2013.

Fig. 15.39: Bamboo Splint-Making Machine by Paresh Panchal [82]

15.6.9. Pepper Thresher

As compared to other conventional threshers, Ravi's thresher can be operated both automatically and manually with higher output and minimal damage. The Spices Board (Ministry of Commerce and Industry, Govt. of India) has recognized his innovation and included it in the Board's subsidy scheme. About 100 kg pepper can be threshed in a one HP machine in ten minutes (60 kg in a HP version). It consumes 3/4 electric units per hour, has threshing efficiency 90 per cent and the damage is about 2-3 per cent.

Fig. 15.40: Pepper Thresher P K Ravi Kerala [80]

15.6.10. Biomass Gasifier

Professor Anil Gupta shows Hollywood film director James Cameron a biomass gasifier invented by Raj Singh Dahiya. Dahiya was born into humble circumstances, but taught himself engineering from a young age. The gasifier -- developed over 20 years -- creates fuel from farm waste bringing power to otherwise isolated areas of the country to light houses, filter water, and run mills.

Fig. 15.41: Biomass Gasifier by Raj Singh Dahiya [82]

15.6.11. Compost Aerator & Leaf Pruner

Decomposed bio-waste has better fertility values. Decomposition can be fastened if the biomass is aerated, humidified and properly mixed. Dhonshi's machine is a tractor PTO driven machine, which can thoroughly mix the bio-wastes and add moisture as well thereby reducing the time of decomposition. The machine can cover a row of wastes disbursed by 100 trailers of size 11 feet x 6.5 feet x 2.5 feet (i.e. total 400 ton) in one hour. Tractor consumes 3.5-4.0 liter diesel per hour. The compost has better fertility value as compared to FYM and vermin compost. Total time for converting the biomass into manure while processed by this machine is 25-40 days, which is otherwise 3-4 months by the conventional methods.

Fig. 15.42: Compost Aerator & Leaf Pruner Gurmeel Singh Dhonshi Rajasthan [80]

15.6.12. Motorcycle-Based Tractor

Mansukhbhai Jagani's motorcycle-based tractor is both cost effective -- costing roughly $318, and fuel efficient -- it can plow an acre of land in 30 minutes with just two liters of fuel.

Fig. 15.43: Motorcycle-Based Tractor by Mansukhbhai Jagani [82]

15.6.13. Milking Machine

Finding skilled labor for milking a small herd of cows is a problem faced by many farmers. But using machines for milking is a luxury which only a large farm or a dairy house can afford. Raghava decided to develop some method of milking, which would be affordable for all farmers. The result: an easy to operate and low cost milking machine that can milk 1.5-2 liter of milk per minute. The machine can be used to remove all the milk from the udder. The cow feels as if it is being suckled and does not experience any pain.

Fig. 15.44: Milking Machine Raghav Gowda Karnataka [80] [108]

15.6.14. Shock Proof Converter

Nicholson has developed an innovative device which converts all electrical lines into shock-free power lines. This is a very useful device for every household/ commercial establishment. The device can be installed just after the energy meter so that each and every connection in the building establishment gets connected to the device and becomes shock-free. The innovator makes different variants based on application and user's requirements

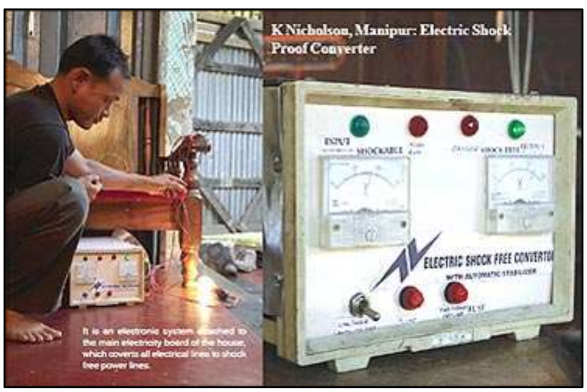


Fig. 15.45: Shock Proof Converter K Nicholson Manipur [80]

15.6.15. Bamboo Lathe Machine

Bamboo needs to be stripped off its outer covering for developing smooth surface to make interior decoration items and utility articles like cups, pen stands, etc. Doing the job manually is time consuming and laborious. The machine developed by Toshi can do all the operations like removing the outer knots, smoothening the surface, internal/external carving and finishing. The machine has soft touch joystick controlled operating system, which facilitates precision in operation. The finished bamboo can be used to make bamboo pet bottles. This bottle has the potential to replace the plastics and tin bottles and cans. The bamboo pet bottles can be made with a capacity of 1 lit, lit, 200 ml etc.

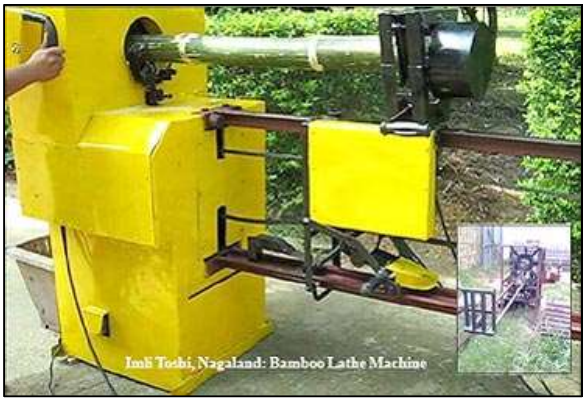


Fig. 15.46: Bamboo Lathe Machine Imli Toshi Nagaland [80]

15.6.16. Improved Mechanized Loom

This innovative mechanized shuttle looms simulates the working principles of traditional Manipuri shuttle loom, except that the new machine runs fully automatic with the help of a half-horse power motor. The output of the machine is 25-50 times more than the traditional shuttle loom, and almost any other power loom. The innovative machine can weave 3-4 fabric per hour whereas the traditional could hardly make 1-2 fabric in a day. Except for the change of bobbin, the machine doesn't require any manpower.

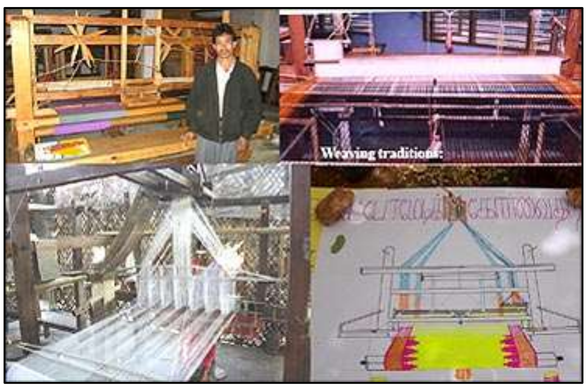


Fig. 15.47: Improved Mechanized Loom Biren Singh Manipur [80]

15.6.17. Kouna Mat Making Machine

Kouna is synonymous with the exotic craft tradition of Manipur. This manual machine, which can even be operated by a low skilled worker or a physically challenged person, can weave two mats per day. The quality of the mats produced is better than those produced by traditional methods.The productivity increases three to four times. A skilled traditional mat weaver can make only one mat in four days, including frill tying. The present machine can weave one mat per day, including frill tying.

Fig. 15.48: Kouna Mat Making Machine Mangi Singh Manipur [80]

15.6.18. Semi-Automatic Transplanter

A farmer from Maharashtra, Pandharinath Sarjerao More developed an affordable, semi-automatic transplanter for timely sowing of onion seedlings The task of transplanting onion seedlings manually is time consuming and labor intensive. Pandharinath's onion transplanter is a tractor drawn semi-automatic unit. It can perform three functions at a time viz. transplanting the onion, applying the fertilizer and making the irrigation channels. More, does not mind anyone copying and using his technology. In fact, he wants the technology to be used widely for the betterment of the farmers.

Fig. 15.49: Semi-Automatic Transplanter [92]

15.6.19. Walnut Cracker, Peeler & Washer

Manual cracking of walnuts involves a lot of time and drudgery. Mushtaq has come up with a walnut cracking machine which can process dry walnuts of various sizes, shapes and thickness to crack them open without damaging the fruit inside. Peeling walnuts is a very labor intensive task involving a lot of drudgery. The sap of walnut skin burns hands and stains clothes as well. The walnut peeler does away with all these problems. Using the walnut washer of Tawseef, the time required to wash, which otherwise is done manually using hands, has been reduced by over 60 per cent. The machine can process approximately 80 kg of walnuts/h. The present version has cracking efficiency about 85 per cent, the peeler has capacity of 70 kg of green walnuts/ h. The washer has capacity of washing 90 kg walnuts/h.

Fig. 15.50: Walnut Cracker, Peeler & Washer Mushtaq Ahmad Dar and Tauseef Ahmad Jammu & Kashmir [80]

15.6.20. Farm Machine

Bachubhai is known as 'Khopadee' (brains) in this small township. To many he may appear a persistent explorer of crazy ideas, but his reputation as a serial innovator has spread far and wide. Doing away with the steering wheel, Bachubhai (58), an inventor and innovator, has developed a lever operated farm machine capable of doing most agricultural operations.

Fig. 15.51. Farm Machine by Bachbhai [92]

15.6.21. Portable Smokeless Stove

This stove uses paddy husk, which is cheaply available, as fuel and gives a smokeless flame. The stove and the fuel, both being cost effective, are easily affordable for common man. It weighs 4 kg. It needs about one kg husk per hour. The stove has higher combustion efficiency in the range of 37.67% when wood is fueled and 29.48% when coconut shell is used as fuel.

Fig. 15.52: Portable Smokeless Stove Ashok Thakur Bihar [80]

15.6.22. Efficient Wood Stove

The walls of this stove have been insulated using brick made from special clay, which reduce heat loss and hence increase efficiency. Different variants of the same for household and commercial use have been developed by Senthil Kumar. The innovator has sold over 15000 units of different versions of these stoves.

Fig. 15.53: Efficient Wood Stove C Senthil Kumar Tamil Nadu [80]

15.6.23. Tube light Frame without Any Choke or Starter

N Das Jethwani of Darjeeling has invented a tube light consisting of a tube light frame without any choke or starter. It is capable of using 80% fused tubes which are considered waste and are usually thrown away.

Fig. 15.54: Tube light Frame without Any Choke or Starter [97]

15.6.24. Low-Height Wind Mill for Lifting Ground Water

Mehtar Hussain and Mustaq Ahemad have developed a drag type, low-cost, low-height wind mill for lifting ground water and can pump water from the depth of about 50 feet.

Fig. 15.55: Low-Height Wind Mill for Lifting Ground Water by Mehtar Hussain and Mustaq Ahemad [97]

15.6.25. Egg Incubator

An egg incubator developed by Milan Jyoti Das from Assam, India, runs on electricity as well as kerosene, and is much cheaper than the ones usually available in the markets, thereby providing a good alternative for rural poultry farmers.

Fig. 15.56: Egg Incubator by Milan Jyoti Das from Assam [97]

15.7. Examples of Frugal Innovation from Abroad

15.7.1. Cycloclean- a Bicycle

In Japan, the social enterprise Nippon Basic has developed the Cycloclean -- a bicycle that purifies water. Taking one of the greatest needs of poor communities and using a ubiquitous piece of technology -- the bike -- designers use pedal pressure to force water through a carbon filter, pumping up to six liters a minute. The bicycle is now in heavy demand in Bangladesh as well!

Fig. 15.57: Cycloclean- a Bicycle [93] [97]

15.7.2. Gravity Light: The Low-Cost Lamp Powered By Sand and Gravity

Martin Riddiford and Jim Reeves, two London based designers, have come up with GravityLight, a simple device charged by a bag that is filled with approximately 9kg of material and hung from a cord below the light. As the bag descends, a series of gears inside the device translates this weight into energy, providing 30 minutes of light.

Fig. 15.58: Gravity Light: The Low-Cost Lamp Powered By Sand and Gravity [97] [99]

15.7.3. Solar Bottle Bulb

As simple as it sounds, a one-liter plastic bottle filled with purified water and some bleach could serve as a light bulb for some of the millions of people who live without electricity. Originally developed by MIT students, the "solar bottle bulb" is now being distributed by the MyShelter Foundation to homes throughout the Philippines. The foundation's goal is to use this alternative source of daylight to brighten one million homes in the country by 2012.

Fig. 15.59: Solar Bottle Bulb by MIT students [97] [100]

15.7.4. Hippo Water Roller at Africa

Hippo Water Roller is a barrel-shaped container; its innovative design allows for 90 liters of water to be placed inside a rolling wheel.

- The Hippo roller is a simple and efficient way to collect much more water, much more easily and in less time. It carries 90 litres (24 gallons) of water inside a rolling wheel.
- The weight of water – 90L (kg) is borne on the ground making it far easier to move than a 20L (kg) bucket carried on the head.
- Five times the amount of water is rolled in the time it takes to collect one bucket of water.
- A steel clip-on handle allows the drum to be rolled by either pushing or pulling depending on gradients, and the design allows two people to pull the roller up very steep gradients.

- The large opening allows for easy filling and cleaning of the interior. The sealed lid ensures hygienic storage of water. [97] [101] [102]

Fig. 15.60: Hippo Water Roller at Africa [97] [101] [102]

15.7.5. EcoFaeBrick

EcoFaeBrick turns cattle waste into bricks that are greener, stronger and 20% lighter than regular clay bricks. The Indonesian organization was set up in early 2009 to tackle the problem of excessive waste in local farming areas.

Cheap, plentiful building materials are needed to meet the massive demand for sound dwellings in informal settlements. In Indonesia, clay bricks could offer an alternative to scrap metal and wood housing, but the quarry mining techniques used to make bricks are expensive and damage the land. EcoFaeBricks, developed by students from Prasetiya Mulya Business School, are made from cow dung with soil extracts and are cured using biogas, reducing the carbon dioxide emitted during the traditional process of using wood-fire heat. The result is a building material that is 20% lighter than clay bricks and has 20% greater compressive strength. Because they make use of a replenishable waste product, EcoFaeBricks are also less expensive than clay bricks. EcoFaeBricks are made in partnership with local communities, providing work opportunities and helping to preserve agricultural land devastated by clay quarrying. Groups in India, Kenya, and Mexico have expressed interest in the technology to meet their own rapid urban development needs. [97] [103]

Fig. 15.61: EcoFaeBrick [97] [103]

15.7.6. Making Music from Trash in Paraguay

Los Reciclados is an orchestra of 25 children from Cateura, Paraguay performing everything from Beethoven to Beatles in concerts around Central and South America, using violins, cellos, saxophones and drums handmade from trash like empty oil cans, cello frames, etc. The project was started by social worker Favio Chavez, who wanted to keep local kids occupied and away from selling trash. [97] [104]

Fig. 15.62: Making Music from Trash in Paraguay [97] [104]

15.7.7. Bottle Raft

In a survival situation, one can’t be picky when looking for salvageable floating devices. When tied or taped together, PET bottles make an excellent DIY raft or kayak. If you live in a hurricane or flood-prone area, you might want to consider storing these highly buoyant materials in your garage — you never know if you or a neighbor might be needing them for survival transportation. Otherwise, they’d make fun and cheap toy rafts for kids in the pool. Federico Blanc built this kayak of plastic bottles to paddle Argentina's Parana River. [110]

Fig. 15.63: Bottle Raft [110] [111]

15.8. Indian Jugaad

Indian Jugaad is really innovative but sometimes there is no consideration for Safety, Environmental Impact, Aesthetics and Sustainability

15.8.1. Jugaad: Coffee Making Machine

Mohammad Rozadeen has modified the normal cooker and made it into an espresso coffee making machine.

Fig. 15.64: Coffee Making Machine by Mohammad Rozadeen [98]

15.8.2. Jugaad: Bicycle Weeder

Bhise has fixed a rod with a blade at the end, to an assembly consisting of only the front wheel and the handle of a bicycle. He has named the assembly as 'Krishiraja', and claims it to be extremely efficient in removing weeds from hard land. It is very useful device for ploughing/inter culture operation in very small farm plots, gardens and kitchen gardens. One can cover 0.08 hectare in one hour

Fig. 15.65: Bicycle Weeder Gopal Bhise Maharashtra [80]

15.8.3. Jugaad: Scooter Flour Mill & Water pumps powered by motorcycles

Scooter Flour Mill made by a local (Sheikh Jahangir) to address the problem of frequent power cuts in Jalgaon, India

Fig. 15.66: Scooter Flour Mill by Mr. Sheikh Jahangir, Jalgaon India and Water pumps powered by motorcycles [90] [94]

15.8.4. Jugaad: Gas-Operated Iron

Brahmam and Ajmeri have developed the gas-operated iron, which is simple in design and have low operating cost. This eliminates the problems associated with irregular supply of electricity and availability of coal.

Fig. 15.67: Gas-Operated Iron Brahmam, Ajmeri [80]

15.8.5. Jugaad: Bamboo Fishing Trap

Fishing is a primary occupation in India and a large populace survives on it. Even in the hinterland, fishing in the rivers and streams provides much needed food and resources. The Galo, a tribe in Arunachal Pradesh in Northeast India is adept in fishing in not one, but many ways. The tribe's tools and techniques are completely eco-friendly too. The common fishing tool used by Galos named 'Edir' is made from locally available bamboo material.

Fig. 15.68: Bamboo Fishing Trap [95]

15.8.6. Jugaad: Halodu – A Blessing for Hill Farmers

The slopes of mountains and the sporadic land patterns do not allow farmers to use tractors to sow or weed on a large scale. Adding to their woes is the climate in the sub-Himalayan hill ranges, which changes drastically. Raj Kumar, a resident of a remote village named Dalchera, Hamirpur district in Himachal Pradesh was another victim of these natural impediments, which exhorted him to innovate a novel means. Utilizing the second hand wheel and chimta from a wreck of his old bicycle, Raj Kumar invented a strange-looking but an ingenious tool for weeding and sowing his fields. This manually operated weeder was named 'Halodu', which would soon change lives of many such farmers living in hilly areas.

Fig. 15.69: Halodu – A Blessing for Hill Farmers [95]

15.9. Few More Case Studies

Many examples are available at

- The Report by Deloitte, Persistent Systems Ltd & Sakal group namely "Inclusive Indian Innovations Perspectives & Case Studies". [240]

- The List of Case Studies on Innovation, IBS Case Development Center, ICFAI Business School, India [401]
- Hundreds of example at Honey Bee website [470]
- Few more case studies along with unique classification and explanation [473]
- National Innovation Foundation: India State wise innovation list [483]
- Report (2013) of Deloitte, Confederation of Indian Industry namely "Innovation Ecosystem in India" [400]

15.10. Poor Innovation Ecosystem Gave Birth to "Jugaad"

R&D took place in the private industry in the form of incremental and reactive product and process improvements… Indian organizations always looked for the easier way of procuring ready and proven technology from companies abroad… Some of the small and medium companies were very successful in developing import substitutes and technologies of their own. **However, reliance on trade secret as a method of IP protection limited the commercial exploitation of some of these technologies**. Use of trade secrets created another issue. **R&D collaborations between industry and academia and national laboratories were relatively very less**. **This prevented a healthy R&D ecosystem from developing**. The private industry was further hindered by excessive duties, controlled pricing structure and restrictive license requirements imposed by the government. They were also resource constrained and had to operate in a controlled economy that was not driven by competition and market forces. **These reasons took away the motivation and drive for structured innovation which required serious investment. It drove them toward unstructured and homegrown techniques such as 'jugaad' and frugal engineering.** [149]

Part IV: Mind Blowing Facts, Which Force to Introspect Every Indian & Give Clues for Developing Better Innovation Ecosystem: Urgent Need of Big Push to Industrial R&D Sector

This part of the book helps you to understand the Bigger Picture – The Innovation Ecosystem – and expected role of each component. Once you understand the inner dynamics of Innovation system of the top innovative nations then it is easy to guess the root cause of unexpected Indian performance at Innovation front. These case studies shows that "There is an urgent need of robust innovation ecosystem to follow the path of "Innovation for GDP Growth" for becoming Developed nation. The Industrial Innovation must be the Leader of Innovation Ecosystem."

Chapter 16: Relationship between Innovation, WCU & Developed Nations

*Phil Baty, Editor, Times Higher Education Rankings stated that "The World University Rankings top 200 is unquestionably a **rich-world list**, **dominated by the economic powerhouses** of the US, the UK and Western Europe, whose universities – at least until the economic crisis – have been generously supported… World-class universities are just one element in making a nation an **innovation leader."** [166]*

*Article published by Times HE World University Ranking stated that "The overall World University Rankings, published each October, are **heavily dominated by the US, and the developed world**. Only five institutions from the 22 emerging economies appear in the top 200 of the overall rankings" [167]*

*Clifford Tan Kuan Lu, The University of Nottingham Malaysia Campus stated that "Simple regression analysis is carried out to determine the correlation between **WCUs per capita** and **GDP per capita** as well as **GDP growth**. The results show that **WCUs per capita is strongly correlated to the nation's GDP per capita**. However, the **WCUs per capita has an insignificant effect on GDP growth**. There is a pronounced increase in significance level when the ranking lists are expanded from the Top 100 to Top 500. This suggests that **it is crucial for a nation to increase the number of WCUs (listed in the Top 500) in order to attain a higher GDP per capita, rather than having a few elite WCUs in the Top 100**." [168]*

16.1. Developed Nations (Higher GDP Per Capita): Relation with WCU & Olympic Games

India is a developing country. India's GDP (PPP) per Capita is USD 5410, which is 123rd position in the world.

16.1.1. World Class University (WCU) and GDP (PPP) Per Capita

The following table shows the list of countries having Top 200 Ranking World Class Universities as per Times Higher Education World University Ranking 2014. This analysis shows that only rich countries are having top 200 ranking world class universities. In this list only China is not Developed nation. Remaining all 25 countries are developed nations. China's GDP (PPP) per Capita is USD 11,904, which is lowest in the list, but still it is 2.2 times higher than India. The wealthy nations can afford the huge financial burden of WCU.

SN	Country	Number of top 200 WCU as per Times Higher Education World University Ranking 2014	Per Capita GDP (PPP)	Developed Nation [153] [154]
1.	China	2	11,904	N
2.	South Africa	1	12,504	Y
3.	Turkey	1	18,975	Y
4.	Spain	1	32,103	Y
5.	Israel	2	32,760	Y
6.	Republic of Korea	4	33,140	Y
7.	New Zealand	1	34,227	Y
8.	United Kingdom	31	36,209	Y
9.	Japan	5	36,315	Y
10.	France	8	36,907	Y
11.	Finland	1	38,251	Y
12.	Taiwan	1	39,600	Y
13.	Belgium	5	40,338	Y
14.	Denmark	3	42,790	Y
15.	Canada	7	43,207	Y
16.	Republic of Ireland	2	43,304	Y
17.	Germany	10	43,332	Y
18.	Netherlands	12	43,404	Y
19.	Sweden	5	43,455	Y
20.	Australia	7	43,550	Y
21.	Austria	1	44,168	Y
22.	United States	77	53,143	Y
23.	Hong Kong	3	53,203	Y
24.	Switzerland	7	53,705	Y
25.	Norway	1	65,461	Y
26.	Singapore	2	78,744	Y

Table 16.1: World Class Universities, GDP (PPP) per Capita and status of Developed countries [152] [153] [154]

This table clearly shows that the financial capability of the nation plays vital role in establishing WCUs. India must raise its GDP (PPP) per Capita to become Developed nation.

16.1.2. GDP & WCU

Clifford Tan Kuan Lu, The University of Nottingham Malaysia Campus stated that "Simple regression analysis is carried out to determine the **correlation between WCUs per capita and GDP per capita as well as GDP growth**. The results show that WCUs per capita is strongly correlated to the nation's GDP per capita. However, the WCUs per capita has an insignificant effect on GDP growth. There is a pronounced increase in significance level when the ranking lists are expanded from the Top 100 to Top 500. **This suggests that it is crucial for a nation to increase the number of WCUs (listed in the Top 500) in order to attain a higher GDP per capita, rather than having a few elite WCUs in the Top 100… A world-class research university is crucial in enhancing a nation's competitiveness in the global knowledge economy**" [168]

In short, there is a strong relation between Developed Country (Developed Economy or High GDP Per Capita) and World Class University (WCU)

Fig. 16.1: There is a relation between WCU and Developed Nation

16.1.3. London Olympic Gold Medals and GDP (PPP) Per Capita

Like WCU, I would like to show that the develop economies dominate several fields. Let's consider the Olympic Games.

The London Olympic Gold Medal list and GDP (PPP) per Capita shows that only nations with high GDP (PPP) or Developed countries can have fair chances of winning the gold medal in Olympic Games.

In London Olympic, total 55 nations got gold medals. The GDP (PPP) of 5 countries is less than India. These 5 countries got the total 11 gold medals out of 302 total gold medals i.e. 3.6%. That is 96.4% medals goes to countries having good GDP (PPP) Per Capita. The rich countries can provide better sports facilities and thus get better results.

Rank	Country	Gold Medals in London Olympic 2012	GDP (PPP) per Capita
24	**Ethiopia**	**3**	**1,354**
50	**Uganda**	**1**	**1,410**
20	**North Korea**	**4**	**1,800**
28	**Kenya**	**2**	**2,265**
47	**Uzbekistan**	**1**	**5,167**
39	Georgia	1	7,165
14	Ukraine	6	8,788
18	Jamaica	4	8,890
45	Tunisia	1	11,092
50	Grenada	1	11,498
46	Dominican Republic	1	11,696
2	China	38	11,904
38	Colombia	1	12,371
42	Serbia	1	12,374
23	South Africa	3	12,504
50	Algeria	1	13,304
22	Brazil	3	15,034
17	Iran	4	15,586
39	Mexico	1	16,463
30	Azerbaijan	2	17,139
26	Belarus	2	17,615
50	Venezuela	1	18,194
42	Argentina	1	18,600
27	Romania	2	18,635
16	Cuba	5	18,796
32	Turkey	2	18,975
25	Croatia	3	20,904
49	Latvia	1	21,381
9	Hungary	8	22,190
50	Bahamas	1	23,102
12	Kazakhstan	7	23,206
30	Poland	2	23,275
34	Lithuania	2	23,876
4	Russian Federation	24	24,120
19	Czech Republic	4	27,344
42	Slovenia	1	27,915
47	Trinidad and Tobago	1	30,439
21	Spain	3	32,103
5	South Korea	13	33,140
15	New Zealand	6	34,227
8	Italy	8	34,303
3	Great Britain & N. Ireland	29	36,209
11	Japan	7	36,315
7	France	11	36,907
29	Denmark	2	42,790
36	Canada	1	43,207
41	Ireland	1	43,304
6	Germany	11	43,332
13	Netherlands	6	43,404
37	Sweden	1	43,455

10	Australia	7	43,550
1	United States	46	53,143
33	Switzerland	2	53,705
35	Norway	2	65,461
	Total 55 countries	Total 302 Gold medals	

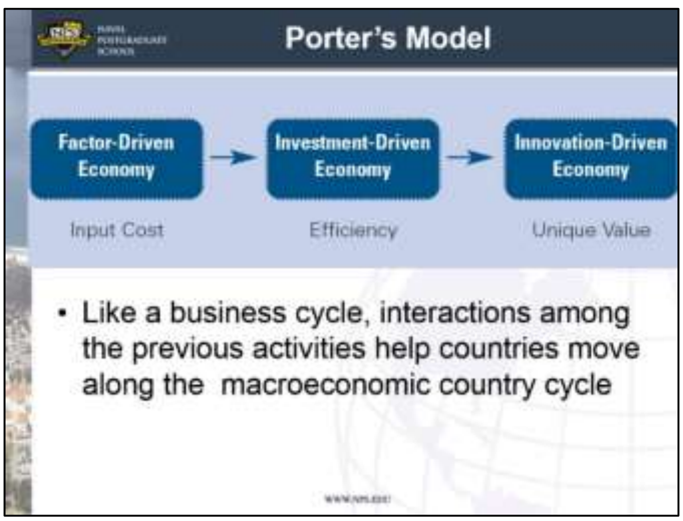
Table 16.2: London Olympic Gold Medals and GDP (PPP) per Capita [152] [155]

16.2. Innovation & Economic Stages of the Nation

The Innovation plays a crucial role in developing of Economy. We have already initiated this issue in the first chapter of this book.

16.2.1. Michael Porter Harvard University: Stages of Economy

Michael Porter, Harvard Business School has developed a competitive index, which examines the microeconomic bases of a nation's GDP per capita. According to this index there are 3 stages of economy



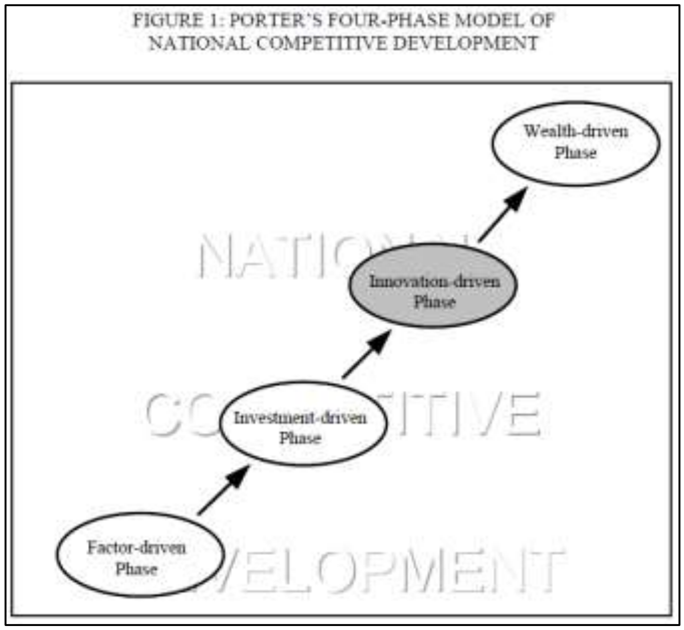


Fig. 16.2: Porter's Model: Factor, Investment, Innovation, Wealth Driven phases of Economy [195] [196]

Fig. 16.3: Company sophistication and economic Development [199]

1. **Factor-Driven Economies**: In the factor-driven stage, basic factor conditions such as low-cost labor and unprocessed natural resources are the dominant basis of competitive advantage and exports. Firms produce commodities or relatively simple products designed in other, more advanced countries. Technology is assimilated through imports, supply agreements, foreign direct investment, and imitation. In this stage, companies compete on price and normally lack direct access to foreign consumers. Companies have limited roles in the value chain, focusing on assembly, labor-intensive manufacturing, and resource extraction. Factor-driven economies are highly sensitive to world economic cycles, commodity prices, and exchange rate

fluctuations; this sensitivity is mitigated only in very large countries such as China, which have large internal markets to attract investment independent of export potential. [199]

2. **Investment Driven Economies**: In the investment-driven stage, a country's advantage comes from producing more-advanced products and services highly efficiently. Heavy investment in efficient infrastructure, business-friendly government administration, strong investment incentives, improving skills, and better access to investment capital allow major improvements in productivity. The products and services produced are not globally differentiated, however, and technology and designs still largely come from abroad. Technology is accessed through licensing, joint ventures, foreign direct investment, and imitation. Nations at this stage normally assimilate foreign technology but also begin to develop the capacity to improve technology themselves. Companies extend capabilities more widely in the value chain, and serve a wider mix of original equipment manufacturing customers and end users. An investment-driven economy is concentrated on manufacturing and outsourced service exports. It remains susceptible to financial crises and external, sector-specific demand shocks, but competitiveness is more stable than in countries depending on commodity cycles and factor prices. [199]
3. **Innovation-Driven Economies**: In the innovation-driven stage, the **ability to produce innovative products and services at the global technology frontier** using the most advanced methods becomes the dominant source of competitive advantage. The national business environment is characterized by strengths in all parts of the diamond, including sophisticated demand conditions and deep supporting industries. Competitiveness emerges in an array of clusters where knowledge, supporting industries, and specialized inputs are present. **Institutions and incentives that enable innovation are well developed**. Companies compete with unique strategies that are often global in scope. **An innovation- driven economy is characterized by distinctive producers and a high share of services in the economy and is quite resilient to external shocks.** [199]

16.2.2. Indian Economy: Factor Driven Stage

The article published in Hindu Business Line stated that "Post-war, Japan developed linearly. And so did South Korea and Taiwan. However, not all development has been linear. Australia and Canada have stayed largely factor-driven. Singapore too has not moved from the factor stage. But, **Italy moved directly from factor to innovation stage**. These exceptions suggest that linear progression is not a must in development; leapfrogging stages seems equally effective. India and China are newcomers to the development scene. **China has moved to the investment-driven stage, but India is yet factor-driven**. India's manufacturing base is relatively less capital-intensive, but its knowledge sector shows vibrancy. Calls are being made to accelerate India's development by pushing the economy into the investment-driven stage. Like China, India too it is suggested should aggressively automate its manufacturing with foreign direct investment, giving it a low-cost advantage in exports and setting the stage for higher-order development to occur. The above suggestion is less than sanguine, at least for now, for two reasons: its benefits are likely to be stymied by India's inefficient port and road infrastructure. At present levels, they are inadequate to handle the high-volume traffic an investment-driven economy would generate; and secondly it could thrust India into a destructive battle with China for international markets in low cost goods. With China's lead advantage in this area, India could lose. Put mildly, India is still not ready for this battle. **A more salient approach is to leapfrog to the innovation-driven stage.** This view is congruent with the Global Competitiveness Report which recognizes India's innovation capabilities. India's world-class engineering and business schools offer opportunities to export higher knowledge in specialized fields. Large pool of skilled workforce in science and technology makes the country attractive to new ventures in product engineering, pharmaceutical research, and healthcare**. In essence, India must exploit its investments in human capital by positioning itself as an innovation-driven economy focused on knowledge-based industries**." [198]

16.2.3. Innovation & Economic Growth

NASSCOM Innovation Report 2012 stated that **"Innovation** is widely recognized as a **key driver of national economic growth**, with countries that rate highly on their propensity to innovate, showing signs of greater economic prosperity. On most occasions, **innovation is driven by corporate firms**, with **external stakeholders** like **governments, regulators, academia** and industry bodies playing key roles in supporting and nurturing innovators and their underlying research. Innovation is receiving high attention across the globe." [162]

Thus there exist relation between economy, Innovation and WCU. That is Developed Nation needs Innovation as well as WCU, both.

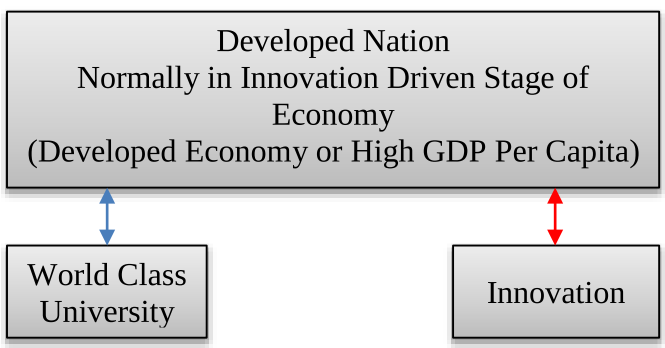


Fig. 16.4: Developed Nation needs Innovation as well as WCU

16.3. Innovation & University

The University plays a major role in Innovation Ecosystem. We have already discussed this issue. The Innovation contribution of the University is shown in the following diagram.

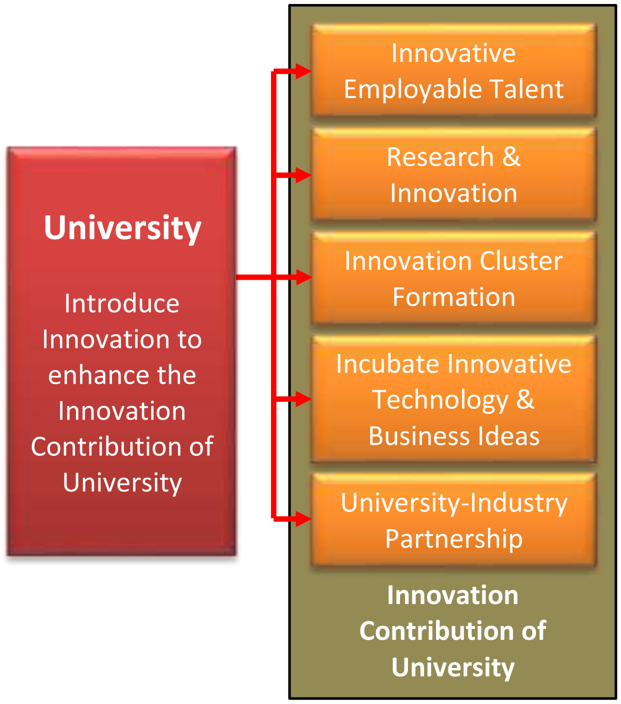


Fig. 16.5: University Innovation Contributions

16.4. Relationship of Developed Nation, Innovation and WCU

Thus finally we can say that all these three factors i.e. Developed Nation, Innovation and WCU are interrelated.

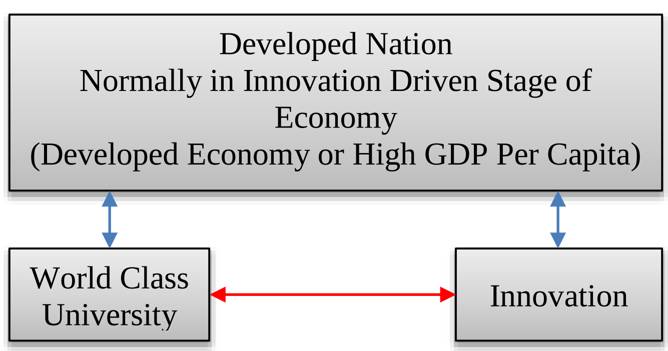


Fig. 16.6: Relation Exist between WCU, Developed Nation and Innovation

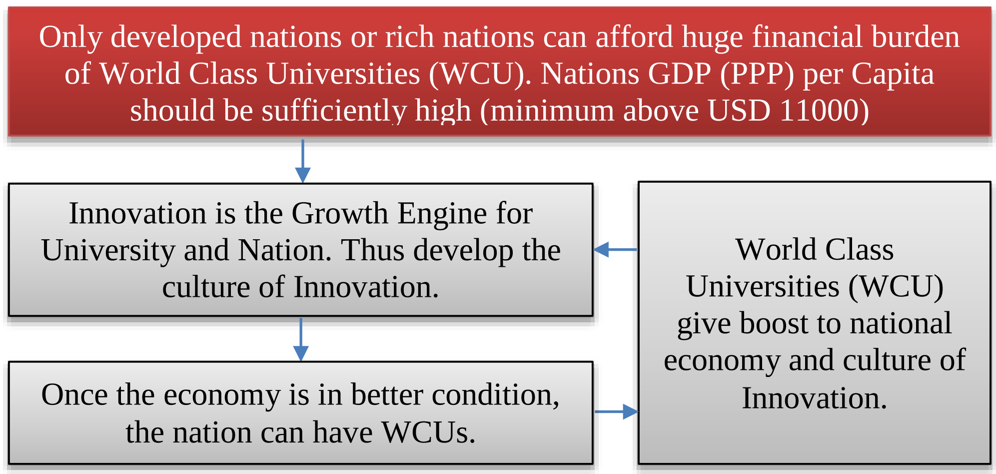


Fig. 16.7: Development cycle of Economy, Innovation and WCU

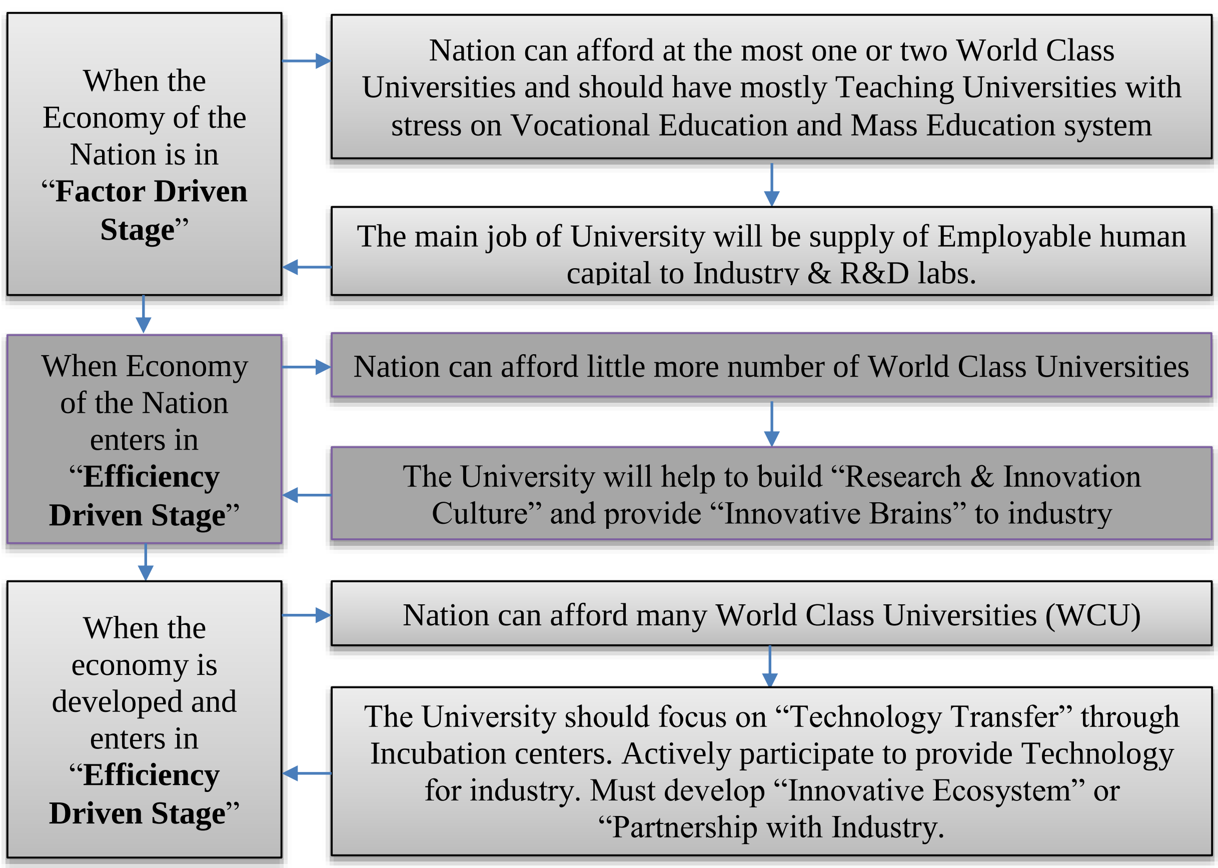


Fig. 16.8: Development cycle of Nation, Innovation and WCU along with stages of economy

I feel that, in "Factor Driven" stage of economy, the role of university should be "Mostly Teaching University". When economy enters in "Efficiency Driven Stage" the role of University should be "Research University involved in Teaching". When economy is in the "Innovation Driven" stage then expected role of University should be "Innovation University involved in teaching and research". The South Korea, Japan and Taiwan have adopted this approach. The detailed case study is included in Part III of this book.

16.5. Complexities of Innovation, Democracy, University, Inclusive Growth and National Development Perspective

Normally, the academicians never think the **model and role of the University** with respect to **National Innovation Ecosystem**. The University is the part of the bigger picture. Many factors affect the growth of University and Higher Education Institutes. In fact, the government economic policies decide the shape and size of the Universities. The National Innovation Policy, Industrial Policy, Science & Technology Policy, democratic on non-democratic nation, non-aligned policy, defense business policy etc. decides the role of the University, the dimension of the University and the contribution of the University. The World Class University Model, which I have suggested in my 5th book namely "Washington Accord & Multi-Objective Integrated Model for Developing WCU" depends upon these policies. The next three chapters highlight this issue. I have considered the examples of three groups of countries to explain this concept.

It is very interesting to see, how other developed nations, changed the role of Universities according to national objectives, political scenario and stages of Economies. Read these Mind Blowing facts in next three chapters.

The spectacular growth of University Empire is observed, when University is part of the National Defense Mission (Military, Space, Missile and Nuclear) and nation is actively involved in Arms Manufacturing Business. The Nations, which focused the Defense Sector Growth for becoming Developed Nation have given major role to University system from Factor Driven Stage of the economy. The best examples are USA and Israel.

The Nations, which focused the Industrial Growth for becoming Developed Nation have neglected the University system at Factor Driven Stage of the economy. The best examples are South Korea, Japan and Taiwan.

The Nations, which took the help of MNC for becoming Developed Nation have uplifted the University system at Factor Driven Stage of the economy. The Singapore is the best examples. Apparently this approach is very attractive. But every coin has two sides. One can't overlook the negative side of this approach. The MNC always protect the interest of parent nation and responsible for virtual brain drain. The national policies should not be over dependent on them.

The economist Edward N Wolff, of New York University, has pointed out that "as of 2007... In America… **just 20% of the people owned 85% of the wealth**, leaving only **15% for the bottom 80%** of the people." [477]

The Human Development Reports has found that **over 80% of all global wealth is owned by the top 20% of the population**. The bottom 40% of the population own about 3% of global wealth. And the **top 1% of the richest global citizens own 40% of the world's wealth**. [478]

Year	Top 1 percent	Next 19 percent	Bottom 80 percent
1983	33.8%	47.5%	18.7%
1989	37.4%	46.2%	16.5%
1992	37.2%	46.6%	16.2%
1995	38.5%	45.4%	16.1%
1998	38.1%	45.3%	16.6%
2001	33.4%	51.0%	15.6%
2004	34.3%	50.3%	15.3%
2007	34.6%	50.5%	15.0%
2010	35.4%	53.5%	11.1%

Table 16.3: Distribution of net worth and financial wealth in the United States, 1983-2010 [479]

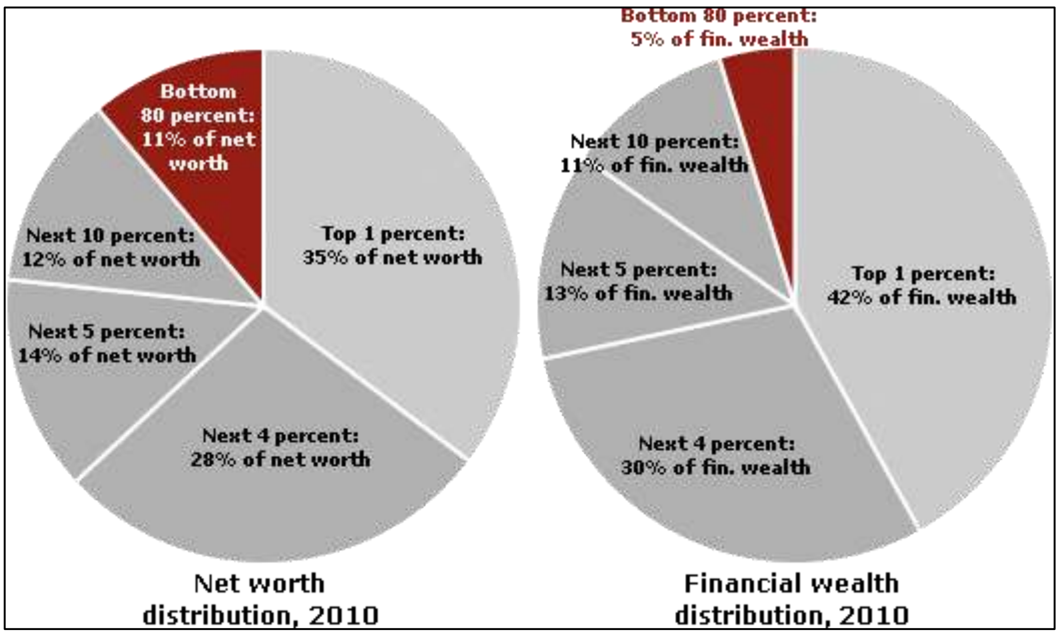


Fig. 16.9: Wealth distribution of USA follows 80:20 Rule (drawn from the careful work of economist Edward N. Wolff at New York University 2012) [479]

In all the three approaches, the growth is non inclusive. In all the three cases, the economy follows the "**Pareto's principle**" (Italian economist Vilfredo Pareto) or "**power law distributions**" or "**80-20 rule**". That is, 80% financial resources are with 20% people and 20% financial resources are with 80% population. In above mentioned systems the government has to protect the interest of 20% wealthy population, which is not possible in democratic countries. But there is no other way to become the developed nation. Choice is yours. [477]

The democratic nations always follow the principle of **inclusive growth**. That is, they try to minimize the skewed economic growth. For economic development, if government of democratic nation tries to over protect the 20% wealthy section of the society then 80% population topple the government in next election. Such governments have no option other than to follow the principle of "Inclusive Growth". But the clustering and concentration of resources are needed to boost the innovation and economic growth. Diagonally apposite approaches are needed for achieving inclusive growth and development of better innovation system. In democracy, it is difficult to focus simultaneously on both of them and keep the balance.

In India, in spite of lot of efforts to implement inclusive growth policies the result is not as expected.

The findings of Gandhi and Walton show that in mid-1990s, India began with two billionaires, worth a combined total of $3.2 billion, and by 2012 there were 46 billionaires with total net worth of $176.3 billion. The latest newspaper report says that the number of billionaires in India has nearly doubled in 2014 to 109 from 59 in 2013, with total net worth of $ 422 billion. The top 10 of them have wealth worth $ 138.04 billion. Mukesh Ambani is the richest person in India with wealth worth $ 26.89 billion. His wealth has increased by about 37% from last year. Gautam Adani, the 10th richest person in the raw, whose wealth has increased by about 152% from last year and worth $ 7.17 billion. The average age of Indian billionaire is 62, where six of them are below 40 years.[iii] The ratio of total billionaire wealth to gross domestic product (GDP) has grown from mere 1% in mid-1990s to 6.6% in 2006 to 9.9% in 2012. **In 2014, the ratio between the billionaire wealth and the GDP has triggered up to 22%**. **Only the top ten billionaires share about 8.09% of India's GDP**. [481]

Income distribution sufficiently unequal even in the pre-independence period but it became more unequal during the plan period after independence. **50% of the total national income goes to the hands of only 20% of the total population** and rest 80% of the total population has to depend on the remaining 50% part of total national income. [482]

Thus I feel that, the Government of India will have to adopt the midway. That is, to keep the balance, simultaneously encourage inclusive growth as well as development of Industrial R&D sector in a big way.

Chapter 17: Drivers of Innovation Ecosystem of South Korea, Japan & Taiwan: Mainly Industry-R&D Driven & Insignificant Role of HE Institutes

*For various reasons, however, **higher education institutions have been regarded as largely irrelevant** to the so called '**economic miracles**' of **Japan** and **Korea**. South Korea's reliance on university-industry linkages are rare. [120] [173]*

*Contribution of university research to industry been limited, but Korea has **not had** any significant technology-based startup successes… As a legacy of the days of massive technology imports, even today in Korea, the term **''technology transfer'' does not refer to the flow of knowledge from the university to industry**; rather to the importation of technologies from countries such as the United States and Japan… **This led to a lack of interest in cultivating and improving technology transfer from the Korean Universities and Research Institutes** (URIs)... In contrast, the universities were expected to educate students, and **did not have a significant research mission**… The teaching mission, however, continues to define the university system in the overall innovation system. This definition is increasingly **out-of-step with the rest of the world**, where there is a growing emphasis on university research as a lever for economic development… Industry's expectation of the university was an ample supply of well-educated graduates, **not the production of commercial knowledge**. [79]*

*Several **Korean** industries put **8 per cent** of turnover into R&D… **The private sector now accounts for 75 per cent of R&D**… The interface between government, industry and academia remains weak in spite of reform efforts. Business rarely looks to universities or institutes for basic research. In 2003, **97 per cent of corporate research funding went to in-house R&D**, with **government research institutes performing only 1 per cent** and **universities 2 per cent**. [121]*

*During the 1960s when the **Japanese government** aspired to strengthen the nation's industrial base, the Ministry of International Trade and Industry launched the Large-Scale Industrial Research and Development System, bridging the partnership between universities and the industrial sector. However, Japanese **universities ended up playing a very small role in it**; while private enterprises became the major driving force of innovation since then. [173]*

17.1. Bloomberg Innovation Ranking 2014: South Korea is a World Leader

Bloomberg Rankings recently examined 215 countries and sovereign regions to determine their innovation quotient. The final universe was narrowed to 110. What follows is the top 30. Innovation was measured by seven factors, including R&D intensity, productivity, high-tech density, researcher concentration, manufacturing capability, tertiary efficiency and patent activity. [70]

As per this report South Korea is the most Innovative country. Sweden, USA and Japan have got 2nd, 3rd and 4th place respectively. Taiwan is at 10th position.

BLOOMBERG RANKINGS

www.bloomberg.com/rank

MOST INNOVATIVE IN THE WORLD 2014: COUNTRIES

South Korea and Sweden lead the world in innovation

Rank	Country	Total score	R&D intensity rank	Manufacturing capability rank	Productivity rank	High-tech density rank	Tertiary efficiency rank	Researcher concentration rank	Patent activity rank
1	South Korea	92.10	3	2	33	3	3	6	2
2	Sweden	90.80	4	22	7	5	13	8	26
3	United States	90.69	10	24	10	1	37	12	5
4	Japan	90.41	5	6	14	8	30	9	3
5	Germany	88.23	9	3	20	6	25	17	6
6	Denmark	86.97	6	56	6	17	27	3	14
7	Singapore	86.07	17	14	15	14	24	4	34
8	Switzerland	86.02	8	16	3	9	35	22	29
9	Finland	85.86	2	21	12	32	5	2	15
10	Taiwan	83.52	7	N/A	30	2	2	5	1
11	Canada	83.21	24	32	11	16	1	13	23
12	France	82.42	16	38	16	15	15	20	10
13	Australia	80.79	14	58	5	25	23	15	41
14	Norway	80.39	25	65	2	26	40	7	20
15	Netherlands	80.32	19	30	18	11	53	24	25

Table 17.1: Bloomberg Innovation Rankings 2014 [70]

17.2. Unique Growth Story of South Korea

17.2.1. Interesting Innovative Ecosystem of South Korea

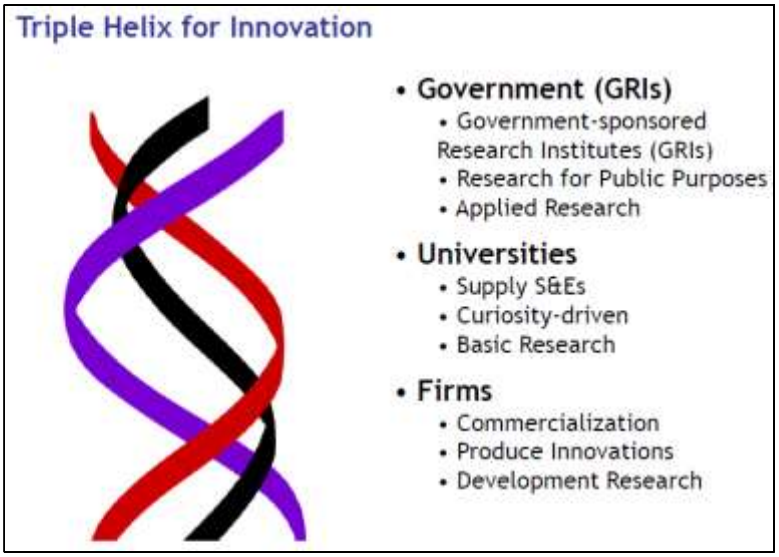


Fig. 17.1: South Korea: Triple Helix for Innovation [116]

Observe the evolution of South Korean Triple Helix for Innovation system. There are 3 components Firms, Government Research Institutes (GRI) and Universities. In South Korean Innovation system the **Industrial Innovation and research contribution is always very high**. They have given maximum stress on industrial R&D.

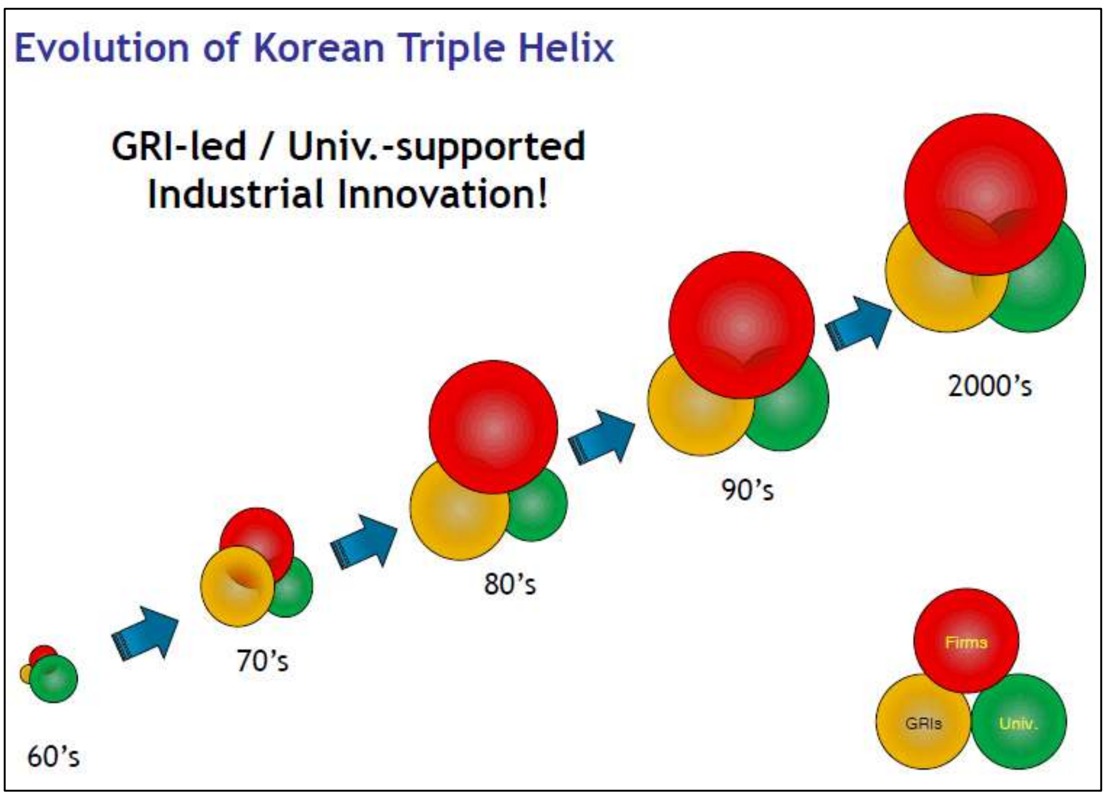


Fig. 17.2: South Korea: Evolution of Triple Helix for Innovation [116]

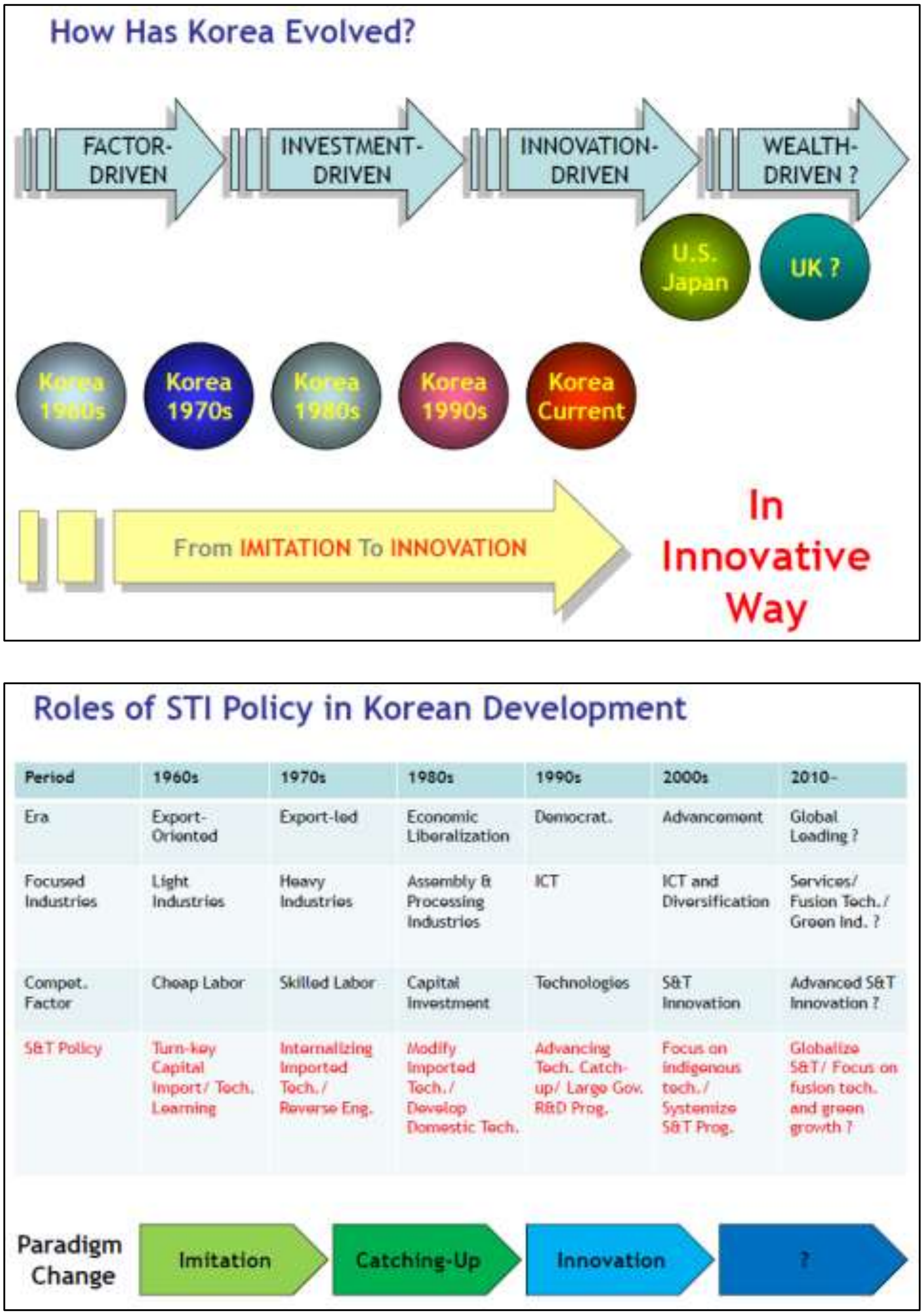
The major role of Government Research Institutes (GRI) is "**Providing Technology Support to Industry**". [116]

Fig. 17.3: Role of Government Research Institutes (GRI) [116]

The South Korean Universities are mostly involved in teaching and basic research. The university-industry links are weak.

Fig. 17.4: Role of South Korean Universities [116]

The secret of South Korea's growth story is "**From Imitation to Innovation**".



Period	1960s	1970s	1980s	1990s	2000s	2010-
Era	Export-Oriented	Export-led	Economic Liberalization	Democrat.	Advancement	Global Leading ?
Focused Industries	Light Industries	Heavy Industries	Assembly & Processing Industries	ICT	ICT and Diversification	Services/ Fusion Tech./ Green Ind. ?
Compet. Factor	Cheap Labor	Skilled Labor	Capital Investment	Technologies	S&T Innovation	Advanced S&T Innovation ?
S&T Policy	Turn-key Capital Import/ Tech. Learning	Internalizing Imported Tech./ Reverse Eng.	Modify Imported Tech./ Develop Domestic Tech.	Advancing Tech. Catch-up/ Large Gov. R&D Prog.	Focus on indigenous tech./ Systemize S&T Prog.	Globalize S&T/ Focus on fusion tech. and green growth ?

Fig. 17.5: How Has Korea Evolved? [116]

Fig. 17.6: South Korea: Weaknesses in Innovation System [117]

South Korea's transformation from 'hermit kingdom' to a global technology power has been the most dramatic development story of the last half century. [121]

As chairman of the Presidential Committee on Balanced National Development Kyoung-ryung Sung said "The Korean government is attempting to fundamentally change the national development paradigm so that it can increase national wealth and competitiveness through an open-door policy and **innovation-driven developments** based on knowledge and technology." [121]

17.2.2. About South Korea

South Korea has 0.03 hectares of arable land per person, placing it in the company of Greenland and Kuwait (Canada has 42 times that). Its energy supplies are minuscule, pumping just 1,000 barrels of oil a day in 2011; it used 2.2 million. The lack of natural resources has long made **innovation a do-or-die question for the country**, but perhaps at no time more than now. [123]

When Korea launched its industrialization drive in the early 1960s, it was a typical developing country, with poor resource and production bases, a small domestic market, and a large population dependent on foreign powers for national security. The economic situation was more than bleak. As far as S&T was concerned, Korea was no more than a barren land. It was under such a setting that Korea started its drive for S&T development and transformed itself into one of the world's most dynamic economies. Korea has succeeded largely because **it invested heavily in human resource development and because it forced companies to compete in global markets**. In the process, however, scientific research capability played second fiddle to **industrial development**. Today, Korea recognizes that it must bolster the basic system for innovation in order to sustain and build on its prosperity. [172]

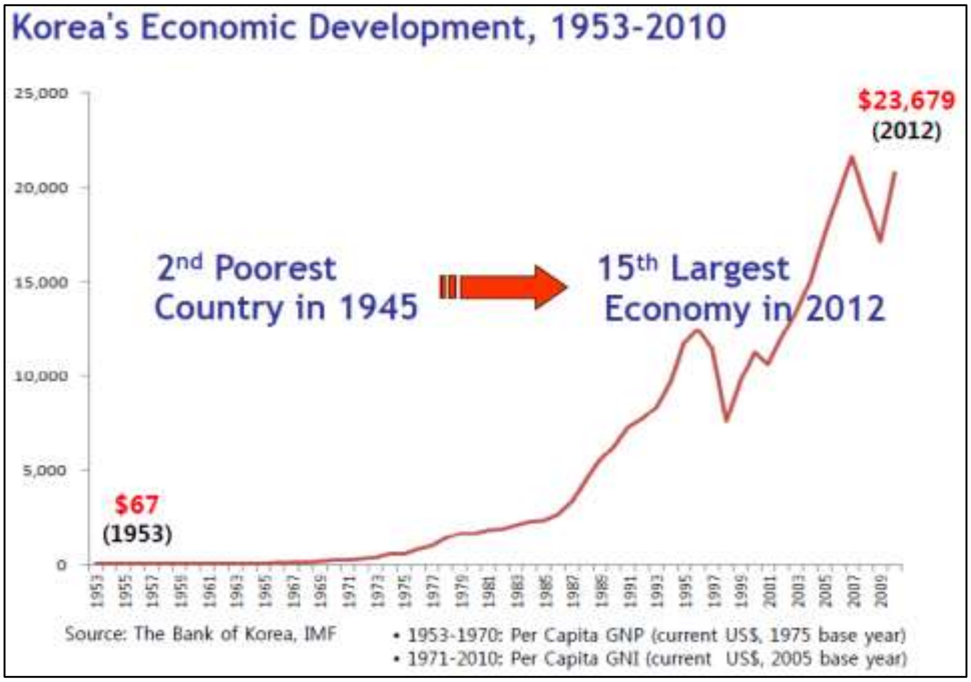


Fig. 17.7: South Korea Economic Growth from 1953 to 2010 [116]

Brief geographical and economic details of South Korea

- Population 50 million (5 crore)
- Developed Country
- Area: 100,210 km² (Area of Chhattisgarh State is 135,194 km²)
- GDP (PPP) USD Million: 1,665,598 (India GDP PPP USD Million:: 4,961,712) [115]
- Per capita GDP (PPP) in USD: 33,140 (India: 5410, China: 11,904, Japan: 36315) [122] [152]
- Over the last 50 years, Korea has enjoyed the highest rate of per capita growth among 28 now-rich countries; it has gone from **being on the level of Zimbabwe in 1961 to matching Japan in 2018**. Korea's growth has been nothing short of stellar. [124]
- The Korean economy is heavily reliant on manufacturing, which makes up close to 27% of the economy. When measuring manufacturing value added as a percentage of GDP South Korea ranks second after China. [114]
- A Small Land with Scarce Natural Resources. Partition gave75 per cent of Korean energy resources to the North Korea. [121]
- Successful countries tend to follow an "arc of development." When they are poor, growth is slow; as they become newly-industrializing countries (NICs), the growth rate takes off; and finally, as they mature, per capita growth slows to around 2% per year. What is truly **remarkable about Korea is that it continued to show superlative growth for such a long time** and even after it had moved from being a poor country on the verge of take-off to a full-fledged NIC. [124]
- South Korea is known as a diligent follower of Japanese industrial policy (cooperative R&D promotion policy). [125]

17.2.3. Puzzle

Why is Korea's record in terms of university technology transfer and the creation of high-tech startups so mixed? Not only has the **contribution of university research to industry been limited**, but Korea has **not had any significant technology-based startup successes** such as Intel or Microsoft in the United States, Huawei or Lenovo in China, or TSMC and Acer in Taiwan. The **remarkable lack of impact of university-based knowledge on Korean development** and the reason that **Korean high-technology clusters remain weak** are the two separate, but interconnected, **puzzles.** [79]

17.2.4. Chaebol

South Korea's industry and economy is **dominated by business conglomerates** called **chaebol** (e.g., Samsung, Hyundai, Pohang Iron and Steel Company, and LG electronics). These companies have moved from safe technology investments and incremental innovation toward **cutting-edge science-based innovation** by adopting Western business practices; as the country has developed, South Korea's historical focus on manufacturing has shifted to services and investing in research and development (R&D) at the forefront of technology. [114]

17.2.5. Details of Innovation Ecosystem of South Korea

- The Korean innovation system can be separated into two periods. The initial period was government led and the later period was private sector led. Beginning in the 1980s, the locus of R&D performance and innovation shifted from the government to private firms. Private firms had grown significantly and believed it necessary to strengthen their own research capabilities to respond to competition in international markets. The organization of the Korean innovation system changed significantly as the Chaebols rapidly increased their in-house R&D investment. Initially, Korean firms invested in consumer electronics R&D, but later concentrated upon the electronics components such as DRAM semiconductors, flat panel displays, and cell phones. To provide an example of the scale of the change, in **1980, 54 firms had R&D centers**, while in **1995, 2,226 firms had an R&D facility**. Though the giant chaebol firms were the most aggressive in establishing R&D centers, recent statistics suggest that more than **two-thirds of existing firms' R&D centers are operated by SMEs**. [79]

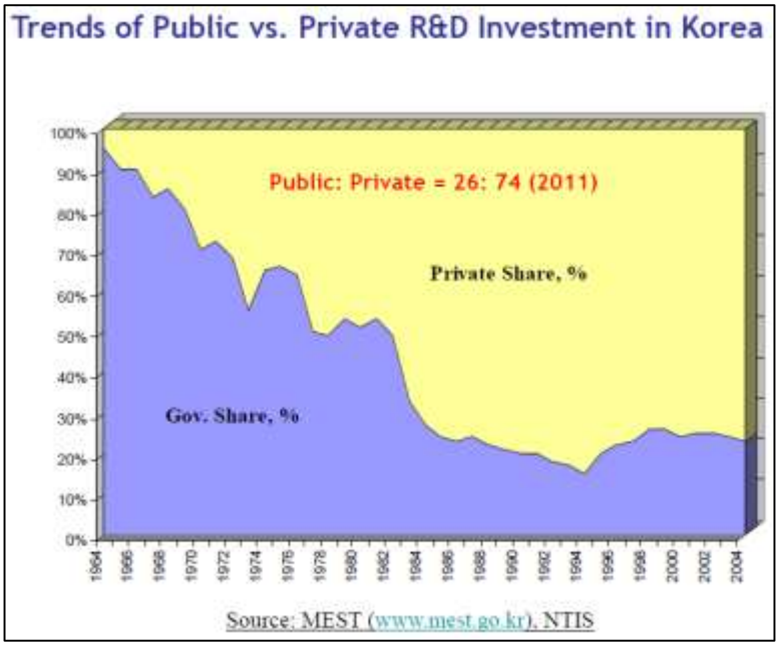


Fig. 17.8: R&D Investment in South Korea: Public vs. Private [116]

Table 12. Distribution of S&T Researchers by Major Field of Study, South Korea (2005)

	Number of Researchers	Share of Total (%)
Natural science	33,248	14.2
Engineering	169,145	72.1
Medical Science	15,143	6.5
Agriculture, Forestry, Fishery	6,813	2.9
Others	10,353	4.4
Total	234,702	100

Source: MEST website, http://english.mest.go.kr/main.jsp?idx=0402020401

Table 17.2: South Korea: Distribution of Science & Technology Researchers by major field of study [173]

Table 13. Number of Researchers by Sector of Performance, South Korea (2000-2005)

	Total	Public Research Institutes (%)	Universities (%)	Companies (%)
2000	159,973	8.7	32.3	59.0
2001	178,937	7.8	30.0	62.2
2002	189,888	7.4	30.4	62.2
2003	198,171	7.3	30.1	62.7
2004	209,979	7.5	28.5	64.0
2005	234,702	6.6	27.6	65.7

Source: MEST website, http://english.mest.go.kr/main.jsp?idx=0402020201

Table 17.3: South Korea: Distribution of Science & Technology Researchers by sector of performance [173]

Table 14. Number of Researchers by Size of Companies, South Korea (2003-2005)

	2003	2004	2005
Large Companies	71,698 (57.8%)	79,910 (59.5%)	91,514 (59.3%)
Small and Medium-Sized	27,390 (22.1%)	28,683 (21.4%)	30,619 (19.8%)
Venture Business	24,942 (20.1%)	25,707 (19.1%)	32,193 (20.9%)
Total	124,030 (100%)	134,300 (100%)	154,306 (100%)

Source: MEST website, http://english.mest.go.kr/main.jsp?idx=0402040301

Table 17.4: South Korea: Distribution of Science & Technology Researchers by size of companies [173]

Table 15. Concentration Rate of Researchers in Top Companies, South Korea (2000-2005)

	2000	2001	2002	2003	2004	2005
Top 5	29.6	24.7	24.7	27.5	29.9	30.6
Top 10	34.8	28.8	28.3	30.9	33.7	34.8
Top 20	40.2	33.0	33.1	48.4	38.8	39.7

Source: MEST website, http://english.mest.go.kr/main.jsp?idx=0402040201

Table 17.5: South Korea: Distribution of Science & Technology Researchers in top companies [173]

- Today, the top South Korean companies compete on high-skilled labor and high quality products not just by incremental innovation on rival technologies (their former fast follower position), but by steadily increasing R&D investments and focus on innovation which are moving them towards a first mover position in some industries. **Korea has 14 companies in the CNN 500 global rankings**, compared to 7 each for Brazil and Russia (CNN Money 2011). [114]

- South Korea is a fast-catcher in S&T since its inception of industrialization. Throughout the process, the state has played an aggressive role particularly during the 1970s-80s by setting up **government research institutes and science parks**. Unlike Taiwan and Hong Kong where SMEs acquire a core role in the economy, South Korean **economy is dominated by Chaebols (big corporations) with the state's strong support**. Since the Chaebols have abundant resources to set up their own in-house research units, their **reliance on university-industry linkages are rare**. In light of this, the Korean government has actively pushed for the university-industry collaboration and has ultimately transformed the role of Korean universities from teaching into research and entrepreneurial activities. [173]
- Today, innovation in the South Korean economy is primarily driven by the private sector, which is dominated by chaebol, such as Samsung, Hyundai, Pohang Iron and Steel Company (POSCO), and LG electronics. These firms typically span a broad spectrum of related and unrelated businesses and **control about 70% of South Korea's total spending on R&D** (with government contributing about 25%). For example, Samsung is diversified across the food, infrastructure, shipbuilding, life insurance, surveillance, recreation, advertising, and financial industries, among others, leading many to refer to South Korea as the "**Republic of Samsung**." [114]
- Technology acquisition was a core strategy for Korean firms. Since the 1980s, Korean firms were aggressive in obtaining technologies from abroad and using them to improve their capabilities. For example, from 1962 to 1982 there were 2,281 technical and licensing agreements, of which 533 were with the United States and 1,287 with Japan. [79]
- **Business innovation** in South Korea has been **accelerated** by substantial R&D investments **by South Korean industry** over the past decade. Samsung's R&D investment has doubled over the past 3 years from $6 billion in 2009 to **$12 billion** in 2012 (with an additional **$30 billion** in facilities and capital investments), going mainly to research in memory chips, LED displays, and systems-on-chip, a next generation semiconductor technology. As a comparison, leading competitors Intel Corp spent $11 billion in 2012, and Taiwan Semiconductor Manufacturing Corporation (TSMC) expects to spend $9 billion in 2013 (Gupta, Kim, and Levine 2013). Hyundai Motor spent **$12 billion** on R&D and facilities in 2012 (compared with Toyota which spent $9.9 billion in 2011). [114]
- With the increase in R&D personnel, the amount of total R&D expenditures and their shares of GDP kept rising since the 2000s accordingly. It points to the fact that R&D has continuously occupied a more important place in the economy. **Private companies**, with their huge team of researchers, undoubtedly spend the most on **R&D (over 70%)**. Likewise, R&D expenditures were highly concentrated in top companies. As of 2005, the **top 20 companies spent about 55.6% of the R&D expenditures** in this regard. Private sector is the dominant source of R&D funding in South Korea. The ratio of private sector to government in terms of funding maintains a stable pattern since 2000. As of 2005, the percentage ratio of private to public was 76 to 24. [173]

Table 16. R&D Expenditure by Sector of Performance, South Korea (in US$ Million)

	Total	Public Research Institutes	%	Universities	%	Companies	%	Total Expenditure as Share of GPD (%)
2000	12,298.8	1,804.6	14.7	1,387.1	11.3	9,107.2	74.0	/
2001	14,307.7	1,918.5	13.4	1,489.2	10.4	10,900.2	76.2	2.59
2002	15,386.4	2,267.0	14.7	1,596.0	10.4	11,523.4	74.9	2.53
2003	16,934.9	2,332.5	13.8	1,716.4	10.1	12,886.1	76.1	2.63
2004	19,702.8	2,632.9	13.4	1,954.6	9.9	15,115.3	76.7	2.85
2005	21,452.4	2,835.6	13.2	2,129.9	9.9	16,486.9	76.9	2.99

Source: MEST website, http://english.mest.go.kr/main.jsp?idx=0402010301

Note: The currency exchange rates of Korean Won to US dollars fluctuate a lot in recent years. We take the exchange rate on 20th January 2010 for analysis, which was about US$ 1 to KRW$ 1,126.

Table 17.6: South Korea: R&D expenditure by Private Sector is more than 74% and total R&D expenditure is above 2.53% of GDP [173]

Table 18. Trend of R&D Expenditure by Source of Fund, South Korea (in Million US dollars)

	2000	2001	2002	2003	2004	2005
Total	12,298.8	14,307.7	15,386.4	16,934.9	19,702.8	21,452.4
Government & Public	3,389.8	3,873.4	4,209.6	4,330.6	4,836.6	5,219.5
Private	8,901.8	10,367.1	11,109.1	12,534.3	14,769.9	16,080.6
Foreign	7.3	67.2	67.8	70.1	96.3	152.2
Government : Private (Percentage Ratio)	28:72	27:73	27:73	26:74	25:75	24:76

Source: MEST website, http://english.mest.go.kr/main.jsp?idx=0402010201

Note: The currency exchange rates of Korean Won to US dollars fluctuate a lot in recent years. We take the exchange rate on 20th January 2010 for analysis, which was about US$ 1 to KRW$ 1,126.

Table 17.7: South Korea R&D expenditure: Source of funding [173]

- In the 1990s, Korean corporate R&D investments began to show results. Though approved technology imports increased to over 200 in 1990, they **decreased in the late 1990s**, partially affected by the Asian Financial Crisis, but also by **improved Korean research capabilities**. This investment resulted in a rising tide of Korean patents filed at the US Patent and Trademark Office (USPTO). For example, in **1985, Korean** inventors were granted **41 patents** at the

USPTO by **2004,** this had increased to **4,428** or nearly two orders of magnitudes. To provide an indication of how important the large firms were in this increase, in **2004 Samsung Electronics Co., Ltd. received 1,604 patents** in the United States, which **ranked it sixth globally**. [79]

- In terms of the volume of overall R&D, South Korean universities play a relatively small role. About 76% of overall spending on R&D is carried out by corporations, 14% is carried out by research institutes, and only 10% is done in universities – a proportion that has increased only slightly over the past decade, from about 7% in 1993. Given the prominent role of firms in R&D in South Korea, it is unlikely that in the foreseeable future universities will become major players, particularly since a great deal of current R&D funded by firms is intended to develop new products – a firm-specific and market-driven form of R&D that is less appropriate for universities. Virtually all corporate research funding (95%) goes to corporate R&D. Of government funding, the majority (52%) goes to research institutes, 19% to corporate efforts **and 29% to universities – the latter largely to research universities (67%) rather than to teaching orientated universities (30%).** Most of the research funding to teaching-oriented universities (7%) goes to institutions located outside of Seoul, suggesting that these funds are being used to strengthen these institutions. In contrast, most of the funds to research universities (66%) goes to institutions within Seoul. Overall, **67% of government research funds go to the top 20 universities**, including a couple of institutions outside Seoul (particularly KAIST and POSTECH), so that only a very few universities have meaningful amounts of research funding. [113]
- As a legacy of the days of massive technology imports, even today in Korea, the term **''technology transfer'' does not refer to the flow of knowledge from the university to industry**; rather to the importation of technologies from countries such as the United States and Japan. An important side effect of this technology acquisition strategy and the subsequent evolution toward internal research was the emergence of autarkic tendency among Korean firms. **This led to a lack of interest in cultivating and improving technology transfer from the Korean Universities and Research Institutes (URIs).** [79]
- There is **dissatisfaction about the quality of university education in South Korea**, its **lack of focus on independent thinking and inadequacy in preparing students for the workplace**. The university system has been criticized for being comprehensive rather than specialized, and having the same broad curriculum with "many courses being mediocre at best and that universities do not challenge students sufficiently. This stems from the original mission of the education system to provide human capital, not ideas. The government's investments over the past decade to improve the education system, as well as work with industry to create more specialized curricula have resulted in improved college rankings. [114]
- In the Korean economy, universities and Research Institutes (RI) have different roles. The RIs were established to undertake **mission-oriented research for the government and for the industry**. In contrast, the **universities were expected to educate students**, and **did not have a significant research mission**. [79]
- Put simply, stemming from the societal need, the university's primary linkage to industry was as a supplier of trained manpower and **not technology transfer**. Gradually, a research mission was grafted on; and communication through publication in academic journals became the technology transfer method of choice. [79]
- Overall then, the role of universities in national R&D is quite small. However, there are two roles in which universities are particularly important. One is the support of basic research, as

distinct from commercial research. While universities carried out only 10% of overall R&D, university faculty contributed 76% of the scientific papers written in South Korea. The second role relates to the training of potential researchers in which universities naturally have a predominant role. [113]

- In 1980, there were 1,230 professors of science and engineering. Of these less than half held Ph.D.s, and of these, **half were educated overseas** and the other half were trained in Korea. In 2001, the number of professors had increased to **6,268 and 14,092** in science and engineering, respectively. In recent years, almost all university professorial staff have Ph.D.s, and many of these are from US research universities. As Korean students went abroad for postgraduate education, they internalized the research orientation they experienced at the foreign universities. When they returned, they imported the belief that university professors should also do research. Reflecting the improving faculty quality and desire to publish, the number of publications in SCI journals increased from **300 in 1981 to 19,279 in 2004**. [79]
- Korean universities today have highly qualified faculty trained in global-standard research. In terms of publications there has been very substantial improvement. **The teaching mission, however, continues to define the university system in the overall innovation system**. This definition is increasingly **out-of-step with the rest of the world**, where there is a growing emphasis on university research as a lever for economic development. There are obstacles. In countries such as the United States, United Kingdom, and China, where universities have enjoyed an active involvement in economic development, the universities have had substantial or total autonomy from central government control. Organizationally, the relationship of the Korean universities to the Ministry of Education is predicated upon a centrally planned approach that **may not encourage entrepreneurial behavior either in terms of securing research dollars or in commercializing research**. [79]
- Traditionally, **neither the university nor the professors had incentives for developing industrial linkages**. It is only recently that there have been incentives for collaboration at an institutional level through technology licensing. [79]
- Industry's expectation of the **university was an ample supply of well-educated graduates**, **not the production of commercial knowledge**. Since firms developed their own technology or imported technologies from advanced countries, they did not expect economically valuable scientific knowledge from the university. There was good reason for this. Most of the patents registered from 1990 to 2001 in Korea came from private firms (78.8%), while **universities produced only 0.5%** and individuals accounted for another 17% of the total patent registrations during the period. [79]
- As stated earlier, historically there has been poor interaction between universities and business with respect to research and innovation. One reason is that most large firms have built up their own training and education facilities. However, given the increasing demands of a knowledge-based economy, the need for a national innovation system based on greater cooperation between government research agencies, universities and the private sector appears to be paramount. [113]
- Further, there was very **little inter-institutional funding**, that is, from industry to university, and research institute to university. Research was performed in institutional silos that were buttressed by major cultural and social differences. Corporate researchers believed, perhaps rightly, that most university faculty were **more interested in publishing their research** than doing work applicable to industry needs. [79]

- Some have attributed the lack of interaction to a lack of trust. Though trust may be lacking, probably more significant is a belief on the part of firms that inventive activities should be performed in-house, and that universities did not conduct research that could lead to marketable inventions. Firms also criticize the direction and the pace of university R&D. Conversely, many university researchers often believe that industrial research is neither creative nor challenging and thus not attractive. **There is only a minimal flow of personnel between universities and industries.** Korean researchers are **reluctant to leave the university to commercialize an invention**. In general, it is accurate to say that university researchers and corporate decision makers inhabit different worlds. [79]
- At the end of the 1980s, Korean policy-makers concluded that closer university–industry relations were desirable. To encourage cooperation, universities received government funds to establish three types of R&D centers: Science Research Centers, Engineering Research Centers, and Regional Research Centers. The centers were meant to encourage cooperative research projects combining university, corporate, and RI staff. [79]
- In the early 1990s, the new Young–Sam Kim government initiated yet another reorganization aimed at strengthening R&D, though there was no specific policy aimed at changing the university's role. **The 1997 Asian crisis led to the reorganization of the Korean university research system and a decision to encourage entrepreneurship based on university research.** An important reform legislated in 1998 was the ''**Special Entrepreneurship Act**'' that was meant to foster high-technology entrepreneurship through technology transfer from the university to the industry. In 1998, legislation was passed creating a new legal infrastructure to facilitate the exploitation of the university's inventions and patents. The Ministry of Education also liberalized the laws governing the involvement of academic researchers in business activities that did not interfere with their normal duties. Universities were urged to create technology transfer offices (TTOs) to handle patenting and manage technology transfer. The TTOs were authorized to license university inventions to the private sector. In response, many universities established new incentive systems to encourage their faculty to file patents through their TTOs. To capture these rights from professors, Korean universities created new regulations. In 1999, regulations were passed allowing universities to establish wholly owned companies to commercialize their inventions and research, though to date few universities have utilized the self-commercialization route. [79]
- Since the late 1990s, the Korean government has supported transitioning to a knowledge-based economy, instituting ambitious goals in the form of publication and patenting targets for public research institutes. Publications have jumped by two-thirds over the past 15 years (from under 10,000 in 1996 to 61,000 in 2011. However, there is suspicion that some of this growth is due to **over publication and over-patenting**, as evidenced by the marginal growth in **citation rates** (about 1% per year over the past 15 years) and relatively **low levels of technology transfer** from universities. In 2007, Korean universities earned USD **3.2 million** from over 600 transfers of technologies to the marketplace. As one benchmark, this compares to more than USD **1 billion** earned by U.S. universities from around 4,000 transfers to the marketplace. [114]

	Korea			US		
	University	GRI	total	University	GRI	total
Royalty Revenue (Million$) (C)	52	101	153	1,764	576	2,340
R&D Expenditure (Million$) (D)	5,645	5,993	11,638	52,232	5,366	57,598
R&D Productivity (%) (C/D)	0.9	1.7	1.3	3.4	10.7	4.1

Table. 17.8: R&D Productivity of South Korea: Low as compare to USA (Source: MOTIE, 2011) [116]

- In addition to the university reforms, Korean industry also became more willing to cooperate with universities for two reasons: First, their in-house R&D operations could not alone handle all the technological paths emerging from technological evolution. Second, the role of scientific knowledge was becoming increasingly important. Korean firms experienced intense pressure to remain abreast of the new developments in science and technology, and they felt that Korean universities could help them. [79]
- Korea's innovation system is characterized by a capacity to learn, produce, and implement high quality processes to produce high quality products; its leadership in manufacturing; and its significant investments in R&D. [114]
- There is no one unambiguously superior model for interaction between the university and the industry. Despite having weak URI– industry interaction and little entrepreneurial clustering, Korean universities and Korean society generally have experienced rapid expansion. It is useful to appreciate the strengths of the Korean system. [79]
- The ministry also runs the World Class University project, a recruitment programme that attracts leading overseas scientists to work in South Korean universities. It is administered by the National Research Foundation (NRF), the country's research funding body. Yongmo Lee, director of the NRF directorate for international affairs and professor of public administration at Konkuk University, says the project's aim is to improve South Korea's research performance and change the balance of its science. "For the past 30 years, we have focused on industrialized science just because (we needed) to move forward, to grow fast...not on the basic science," he says. "But if we have reached a certain level of economic development for the past few years, then we need to move to fundamental research from industrialized or applied research." [137]
- For various reasons, however, higher education institutions have been regarded as largely irrelevant to the so called 'economic miracles' of Japan and Korea. Western observers appear to have been less focused on the question of skills formation in Korea beyond applauding its general emphasis on human resource development. This is interesting particularly because the Korean government had taken a very proactive role in strengthening vocational education systems, certainly in comparison with Japan, and possibly also compared with other international peers. In Japan, the Imperial University Ordinance of 1886 that defined the purpose of the modern university system was clearly based on the German and other western models of higher education, which was transferred to Korea during the colonial period (1910-

1945), and the education system in both Japan and Korea was reorganized under US influence following the second world war and political independence in 1945. One critical change made under the occupation government, which was since been much criticized by the Japanese, was for vocational colleges to become integrated into universities. [120]

17.2.6. Government Measures from 2008-12 and Policies from 1960-2000

The following tables shows the measures of Government of South Korea for becoming Topmost Innovative country of the world. Many measures are for building culture of innovation at Institute of Higher Education or Universities in South Korea.

Name of the Support measure by South Korea	1st Priority	Start date	End date	Estimated public budget in 2010 in euro	Comment
Global Frontier Programme	Global top-level basic and fundamental research outputs, focusing on the long-term fundamental technology in emerging area	2010	2021	€ 9.67m	• € 773m investment for 10 years • 15 research areas • N0 private sector co-financing
Promotion of World Class Universities (WCU)	**Attraction of renowned top class foreign researchers as full-time professors**	2008	2012	€ 103m	• € 531m investment in universities for 5 years • http://wcu.nrf.re.kr
Participation in International Thermonuclear Experiment (ITER)	Commercialization of nuclear fusion energy until 2040s	2004	2019	€ 9.86m	• € 27m government investment • No private sector co-financing
Leaders in Industry-university cooperation (LINC)	Support 50 **Universities** for regional innovation	2012	-	€ 148m in 2012	• Integration of various industry university cooperation programme
Fostering leading industry in wide regional economic area	Promotion of 1~2 representative industry in each of Korea's 6 wide economic area	2009	-	€ 180m	• Selection of 12 leading industry and 20 projects
Development of technology in regional industries	Strengthening capability of technology development in regional company	2008	-	€ 70m	• Managed by regional technology park • 25~50% of Private sector co-financing
Establishment of regional	To provide regional companies with research	2008	-	€20m	• Support for 45 centres in 2011

innovation centre (RIC)	and essential equipments in **universities**				
2nd round support for Technology Licensing Office (TLO)	Three types of support for TLO in **universities and government-supported research institutes**	2011	2015	€6.4m	• 24 universities and 15 GRIs • 30% co-financing from them
Support for technology holding company	Activation of technology holding company from **universities** and GRIs	2010	2012	€1.9m	• Five THC from universities and 1 from a GRI • More than 30% of their own funding
Development of components and materials technology	Support for R&D in 20 core areas of materials technology	2010	2012	€50m	• Focus on core import materials for next 10 years • 25~50% private sector co-financing

Table 17.9: The Republic of Korea (South Korea): Research and innovation policy measures (dark shaded region denote Higher Education Measures) [78]

The following Table shows the Korean growth and major policies from year 1960 to 2000.

	1960s	1970s	1980s	1990s	2000s
Population (million)	25	32.2	38.1	42.9	48.4
R&D budget as % of GDP		0.39% 0.42%	0.56% 1.52%	1.87% 2.37%	2.39% 2.99%
Development stage (sources of competition)	Imitation or factor-driven stage (cheap labour = 55% of growth)	Internalisation or investment-driven stage (manufacturing capability)		Generation or innovation-driven stage (innovative capability – technology = 55% of growth)	
Major industrial policy direction	Expand export-oriented light industries	Expand export-oriented heavy industries	Expand technology-intensive industries	Promote high-technology innovation, develop information infrastructure, strengthen market-oriented technological innovation, accelerate import liberalisation	Transition to knowledge-based economy. Industrial strength based on restructuring, continued investment, advancement into new markets, upgrading towards higher industrial value chains
Science and Technology (S&T) policy and role of government	Scientific institution-building – MOST/KIST – S&T Promotion Act – five-year economic plan includes S&T	Scientific infrastructure-setting – GRI – Daedeok science town – R&D promotion act – highly qualified personnel	R&D and private lab promotion – NRDP – promoting private research labs – promoting industrial R&D	Leading role in strategic areas – HAN – promoting cooperative R&D – policy coordination – GRI restructuring	New challenges. Head of MOST is made deputy prime minister. OSTI is created to coordinate across departments, promoting indigenous innovation (IPR emphasis)
Macroeconomic policy framework	Prepare legal and institutional bases to support industrialisation	Maximise growth and increase government intervention into the markets	Stabilise macroeconomy and enhance private autonomy and competition	Liberalise trade and FDI and reform financial markets and restructure the economy	Encourage FDI, encourage transparency, FTA with the US and others, Vision 2030 plans
Human resources	Decrease illiteracy	Increase vocational training	Expand higher education system	Develop: – highly skilled human resources in strategic fields – lifelong learning systems	Literacy rates: – 98% (2002) HR innovation, increasing: – market influence – productivity – international
Education policy	Plan education for economic development – improve teaching quality – increase number of college graduates with engineering major – develop medium-skilled HR		Enhance lifelong learning and non-traditional education – government-led, partial market approach – develop highly skilled HR in strategic fields – increase research funds in R&D		Improve quality of education and research: Brain Korea 21 (BK21) encourages R&D research. Phase 1: 1999–2006. Phase 2: 2006–2013, NURI (regional education)

Table 17.10: Korean growth and major policies from year 1960 to 2000 [121]

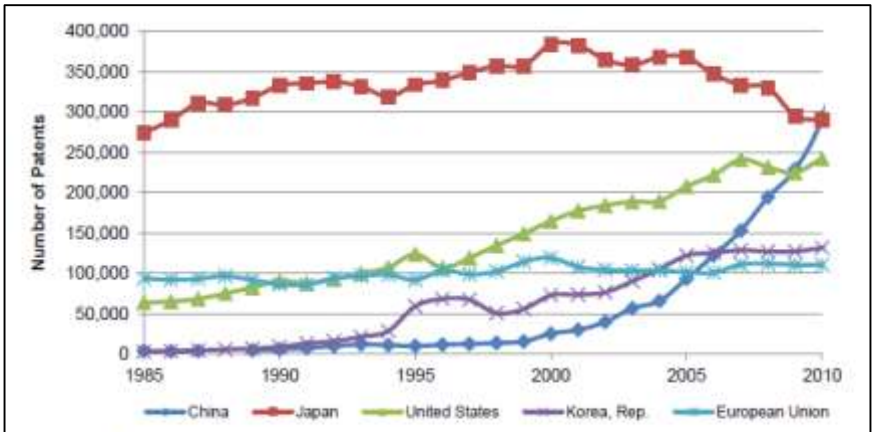
17.2.7. South Korea: Patent, Research Publications, Number of Researchers

The number patent application clearly indicate the rate of innovation of any country. Let's see following Table and Figure for position of South Korea, Japan and USA.

Rank	Country	Patent applications per million population
1	South Korea	**2,962**
2	Japan	**2,250**
3	Switzerland	1,013
4	Germany	902
5	United States	**856**
6	Finland	665
7	Denmark	539
8	Austria	489
9	Netherlands	444
10	China	396

Table 17.11: Patent applications per million population for the top 10 origins, 2012 [112]

The number of patents are directly proportional to number of Innovations. The following figure clearly shows the position of South Korea, USA, UK and India.



Source: World Bank.

Figure 11. Trends in Patent Applications (through the Patent Cooperation Treaty or a National Patent Office) by Residents of South Korea and Selected Other Countries, 1990–2010

Fig. 17.9: Trends in Patent Applications (through the Patent Cooperation Treaty or a National Patent Office) by Residents of South Korea and Selected Other Countries, 1990–2010 [114]

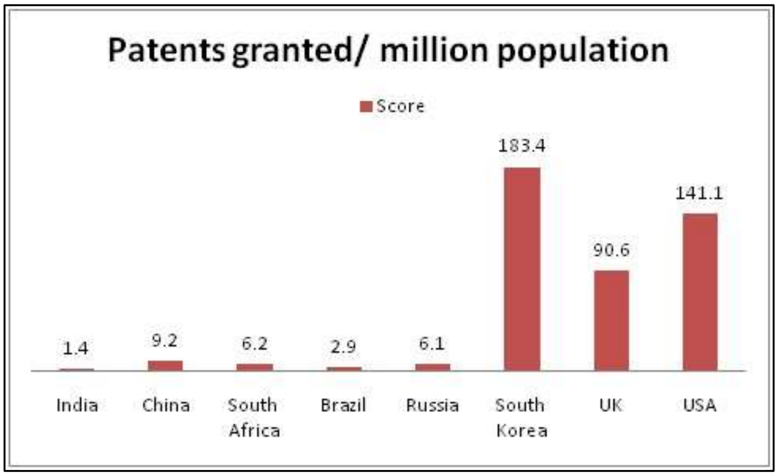


Fig. 17.10: Patents granted per million population [96]

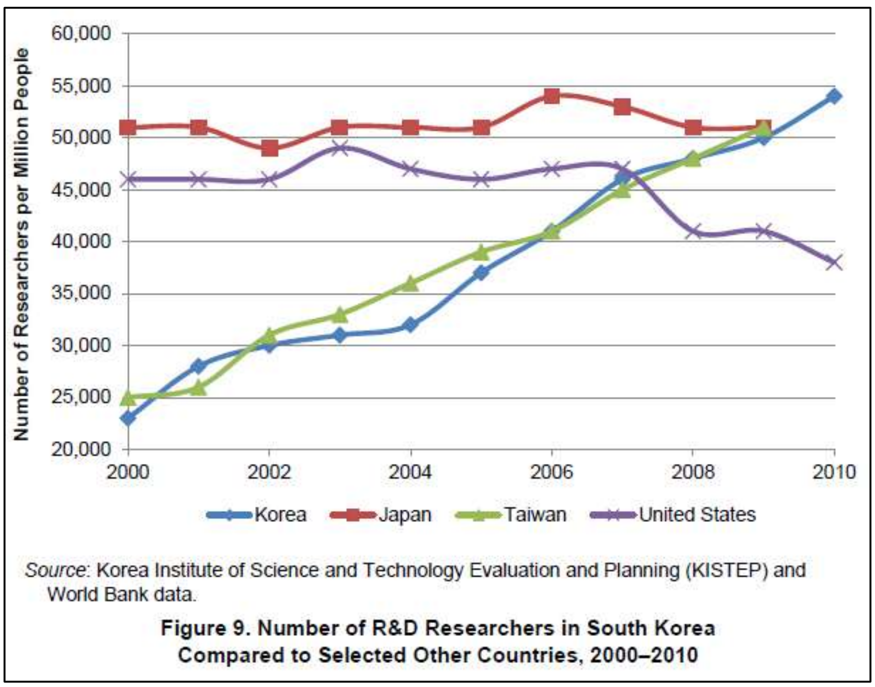
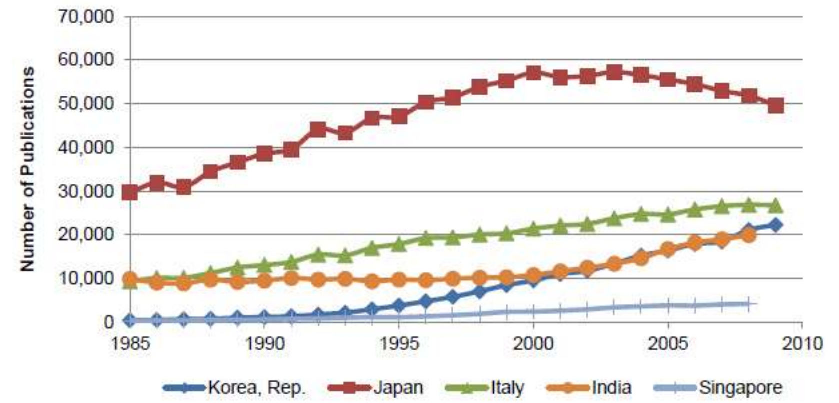


Fig. 17.11: Number of Researchers per million population: Korea, Japan, Taiwan, USA [114]



Source: World Bank data.

Figure 10. Scientific and Technical Journal Article Publication Trends for South Korea Compared to Japan and Selected Other Countries, 1985–2010

Fig. 17.12: Scientific and Technical Journal Article Publication Trends for South Korea Compared to Japan and Selected Other Countries, 1985–2010 [114]

17.2.8. South Korean World Class Universities

In 2008, the Korean Government invested € 531 million (Rs. 4173 crore) for development of World Class Universities. The higher education sector of South Korea develops at a stable pace in recent years. [78] [173]

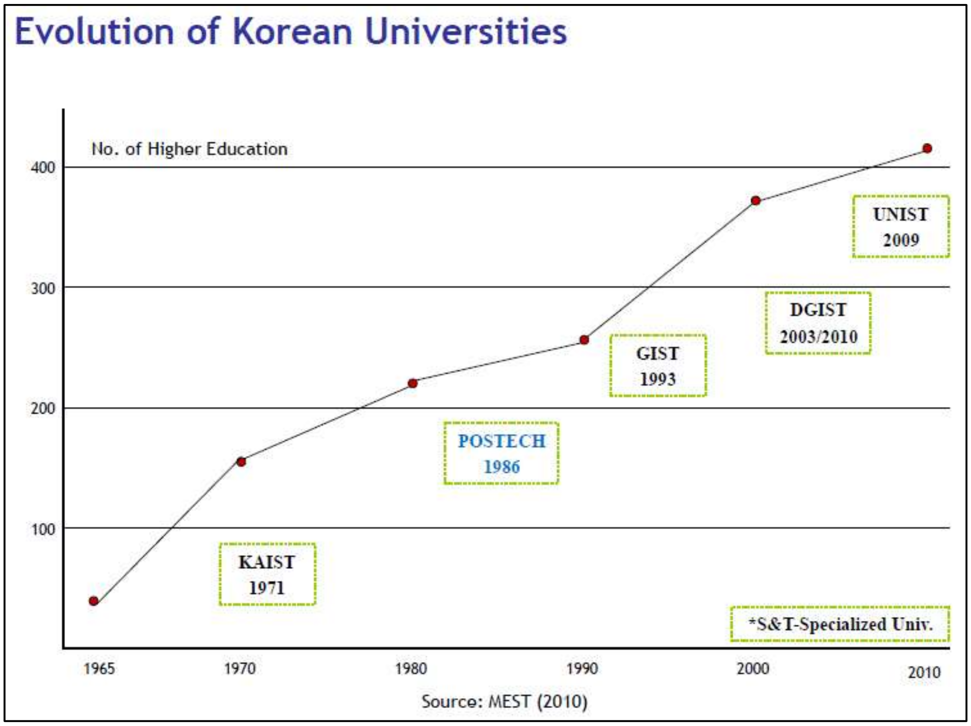
Perhaps another important reason why Korean universities fall low on the international rankings is due to the **lack of research opportunities at their colleges** (WCU, 2008-2012). Although, the **National Project Towards Building World Class Universities (2008-2012)** does highlight this inadequacy, especially when compared to American universities, and it does bring to light the need to hire highly qualified foreign professors and researchers to do joint research with Korean professors and the need for halting brain drain to especially the United States (WCU, 2008-2012). As a matter of fact, the government is willing to allocate **165 billion won to Korean universities this year alone (2008)** to assist them in attracting more high-quality foreign professors and researchers from abroad. Taken as a whole the project invites world-class scholars and researchers to develop world class academic programs and departments in Korean universities, which will ultimately lead to the creation of world class institutions of higher education in Korea (WCU, 2008:2-1). [136]

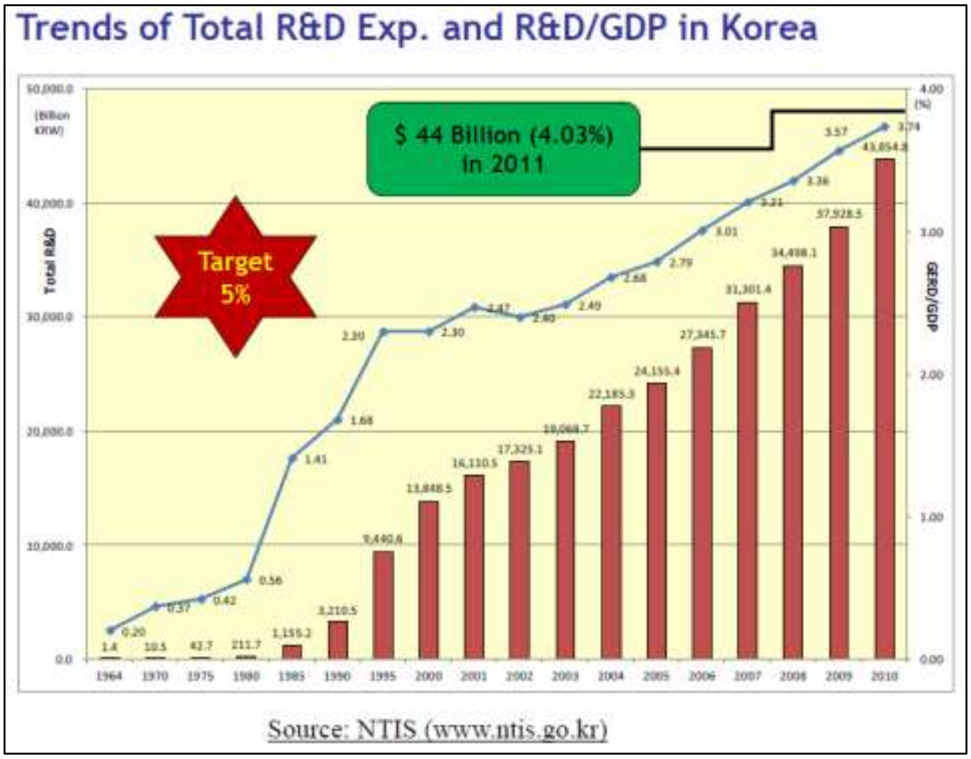
As per Times Higher Education World University Ranking 2014, the South Korea is having **four** top 200 World Class Universities.

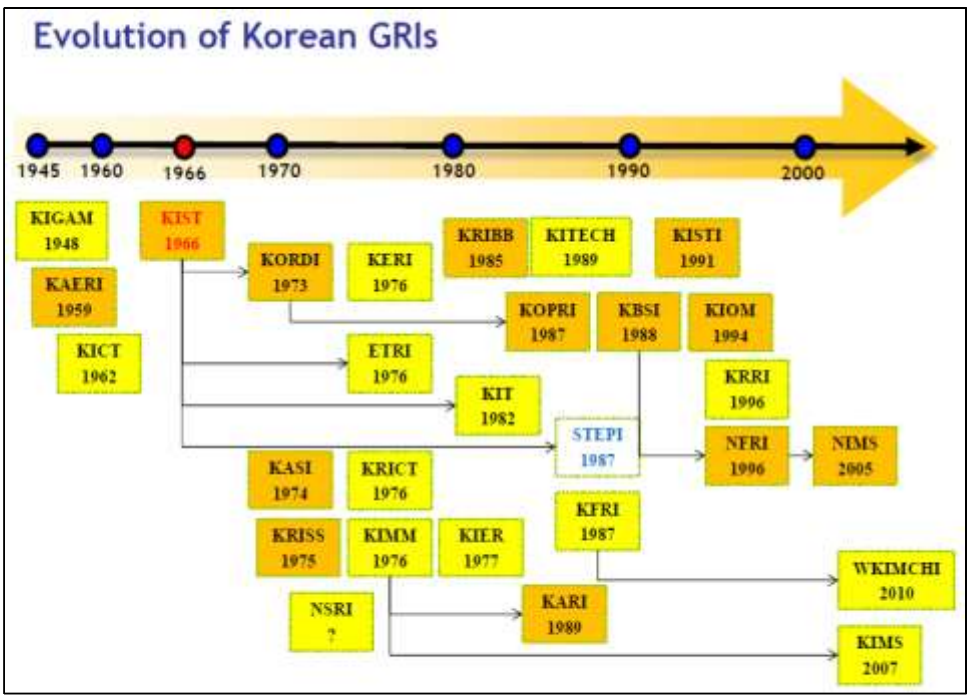
Times Higher Education World University Ranking 2013-14	Times Higher Education World University Ranking 2010-11	South Korean World Class Universities	Year of Establishment	Annual Budget in Rs. Crore	References

44	109	Seoul National University	1946	4064	[127]
56	79	Korea Advanced Institute of Science and Technology (KAIST)	1971	4590	[126]
60	28	Pohang University of Science and Technology (POSTECH)	1986	1661	[128]
190	190	Yonsei University	1985	16824	[129]
201-225		Korea University	1905		
201-225		Sungkyunkwan University (SKKU)	1398		
351-400		Hanyang University	1939		

Table 17.12: South Korea: World Class Universities [66] [137]




Trends of Total R&D Exp. and R&D/GDP in Korea
$ 44 Billion (4.03%) in 2011
Target 5%
Total R&D
(Billion KRW)
GERD/GDP
(%)
50,000.0
40,000.0
30,000.0
20,000.0
10,000.0
0.0
4.00
3.00
2.00
1.00
0.00
1964 1970 1975 1980 1985 1990 1995 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
1.4 10.5 42.7 211.7 1,155.2 3,210.5 9,440.6 13,848.5 16,110.5 17,325.1 19,068.7 22,185.3 24,155.4 27,345.7 31,301.4 34,498.1 37,928.5 43,854.8
0.20 0.37 0.42 0.56 1.41 1.68 2.30 2.30 2.47 2.40 2.49 2.68 2.79 3.01 3.21 3.36 3.57 3.74
Source: NTIS (www.ntis.go.kr)


Evolution of Korean GRIs
1945 1960 1966 1970 1980 1990 2000
KIGAM 1948
KAERI 1959
KICT 1962
KIST 1966
KORDI 1973
KERI 1976
ETRI 1976
KIT 1982
KASI 1974
KRICT 1976
KRISS 1975
KIMM 1976
KIER 1977
NSRI ?
KRIBB 1985
KITECH 1989
KISTI 1991
KOPRI 1987
KBSI 1988
KIOM 1994
KRRI 1996
STEPI 1987
NFRI 1996
NIMS 2005
KFRI 1987
WKIMCHI 2010
KARI 1989
KIMS 2007

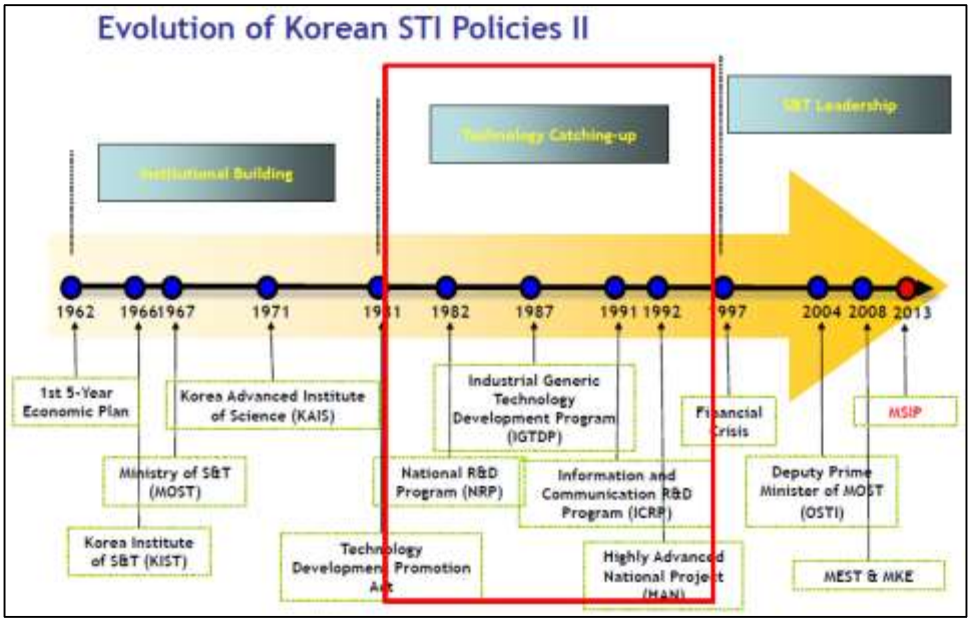


Fig. 17.13: **Time Line** of evolution of Korean Universities, GDP Government Research Institutes (GRI), Science-Technology Institutes (STI) Policies and Role of Universities [116]

17.3. Japan: Business Driven Innovation Ecosystem

During the 1960s when the Japanese government aspired to strengthen the nation's industrial base, the Ministry of International Trade and Industry launched the Large-Scale Industrial Research and Development System, bridging the partnership between universities and the industrial sector. **However, Japanese universities ended up playing a very small role in it**; while **private enterprises became the major driving force of innovation** since then. [173]

The Basic Law for Science and Technology was enacted in 1995, stipulating the government's responsibility to introduce five-year plans for S&T advancement. **R&D activities in universities were also buttressed by education reforms** since the 1990s that enable universities and their personnel to undertake such activities. The implementation of the Basic Law has successfully steered the development of research and development in Japan, making the country more innovative in the last decade. [173]

Research, development and innovation are seen as strategic priorities by the Japanese government as well as by industry. The capacity to mobilize very large resources in pursuit of strategic priorities is a feature of the Japanese innovation system. Research expenditure represents about 4% of GDP. METI supports innovative investment through research and funding agencies such as the National Institute of Advanced Industrial Science and Technology and the New Energy and Industrial Technology Development Organization. **However large corporations provide about 80% of the national research expenditure.** [224]

Japanese large corporations have close links with central government. The strategic visions developed by METI are used as guiding maps for future industrial developments by industry associations and large conglomerates such as Mitsubishi, Honda, Mitsui and Sumimoto. They allow for large strategic investments with long-term objectives. They also facilitate the access of the world markets through strong marketing strategies and networking. **In the 1980s most of their research was conducted by in-house laboratories. More recently, they have been developing research collaborations with universities and research institutes**. [224]

Similar to South Korea, Japan's innovation system is business-driven. For research capacity, an overwhelming majority of the **R&D performing institutions reside in business enterprises (over 80%),** significantly outnumbering those in universities & colleges (over 10%), non-profit institutions and public organizations. Accordingly, the industrial sector and the universities & colleges compose the majority of R&D personnel. As of 2005, the former employed about **58.2%** of the R&D personnel, while the latter 34.2%. [173]

In August 2011, METI released a 5-year science and technology plan. It identifies innovative culture and funding for science and technology as a national priority. The plan includes a target of **R&D of 4% of GDP**, with **corporations contributing 3%** and Government 1% (about £190 billion). [224]

Table 21. Number of R&D Performing Institutions, Japan (2000-2004)

	Total	Business Enterprises	Non-Profit Institutions	Public Organizations	Universities & Colleges
2000	27,061 (100%)	22,789 (84.2%)	613 (2.3%)	632 (2.3%)	3,027 (11.2 %)
2001	22,056 (100%)	17,903 (81.2%)	523 (2.4%)	615 (2.8%)	3,015 (13.7%)
2002	18,468 (100%)	14,258 (77.2%)	520 (2.8%)	599 (3.2%)	3,091 (16.7%)
2003	29,663 (100%)	25,440 (85.8%)	507 (1.7%)	596 (2.0%)	3,120 (10.5%)
2004	28,608 (100%)	24,290 (84.9%)	488 (1.7%)	601 (2.1%)	3,229 (11.3%)

Source: MEXT website, http://www.mext.go.jp/english/statist/06060808/pdf/140.pdf

Table 17.13: Japan R&D: Above 77% by Business Enterprises, the contribution of University is just above 10% [173]

Table 22. R&D Personnel by Occupation, Japan (as share of total, %)

	2000	2001	2002	2003	2004	2005
Total	1,022,079 (100%)	1,000,014 (100%)	972,495 (100%)	968,092 (100%)	994,348 (100%)	1,009,937 (100%)
Industry	604,544 (59.1%)	581,721 (58.2%)	561,735 (57.8%)	555,772 (57.4%)	580,628 (58.4%)	587,414 (58.2%)
Government	59,025 (5.8%)	59,254 (5.9%)	62,768 (6.5%)	63,906 (6.6%)	61,893 (6.2%)	61,769 (6.1%)
Universities & Colleges	330,509 (32.3%)	331,049 (33.1%)	330,654 (34.0%)	331,499 (34.1%)	335,983 (33.8%)	345,274 (34.2%)
Private Research Institutes	28,001 (2.7%)	27,990 (2.8%)	17,338 (1.8%)	16,915 (1.7%)	15,844 (1.6%)	15,480 (1.5%)

Source: MEXT website, http://www.mext.go.jp/english/statist/06060808/pdf/141.pdf

Table 17.14: Japan: 58% R&P personal are from Industry [173]

Table 23. R&D Expenditure by Sector, Japan (2000-2004)

Year	Total (million US$)	Business Enterprises (%)	Non-Profit Institutions (%)	Public Organizations (%)	Universities & Colleges (%)
2000	178,718.9	66.7	4.3	9.3	19.7
2001	181,337.4	69.3	2.2	9.0	19.6
2002	182,950.8	69.4	2.0	8.9	19.7
2003	184,367.3	70.0	1.9	8.7	19.4
2004	185,831.2	71.2	1.8	8.8	19.3

Source: MEXT website, http://www.mext.go.jp/english/statist/06060808/pdf/146.pdf
Note: The currency exchange rates of Japanese Yen to US dollars fluctuate a lot in recent years. We take the exchange rate on 20th January 2010 for analysis, which was about US$ 1 to 91.145 Yen.

Table 17.15: Japan: 66% R&D expenditure by Business Enterprises [173]

17.4. Taiwan: Huge R&D Investment in Business Enterprise

Nevertheless, despite the government's significant role in shaping the rules and regulations for R&D activities in Taiwan; it is actually the scientific community and the market that determine its direction, such that "**Innovation in Taiwan…is a result of domestic individuals and independent firms**" (Mahmood and Singh, 2003: 1052). SMEs are the driving force of innovation in Taiwan's economy, and they have constituted nearly 98% of all the Taiwanese enterprises. [173]

Taiwan has demonstrated that focused investments in applied research and a systematic system for absorbing and disseminating foreign technology can produce globally competitive high-tech industries. Thanks largely to **public-private partnerships** led by the Industrial Technology Research Institute (ITRI), Taiwan has become a world leader in semiconductor manufacturing, digital displays, and notebook computers. Now Taiwan is developing fast-growing innovation clusters in fields such as semiconductor design, flexible displays, and biomedical devices. [225]

After reviewing the research and development, especially examining the role of different sectors including the state, industry and the university in promoting technology and innovation in Taiwan, we have witnessed the driving force for innovation and technology development originated from a state-led model towards a **more firm-led approach in Taiwan**. [173]

Table 5. R&D Expenditure (US$ Million) by Sector, Taiwan (2003-2007)

	Total Expenditure	Business Enterprise	Government	Higher Education	Private Non-Profit	As share of GDP (%)
2003	7,591.9 (100%)	4,769.2 (62.8%)	1,872.8 (24.7%)	902.8 (11.9%)	47.2 (0.6%)	2.31
2004	8,227.2 (100%)	5,321.7 (64.7%)	1,910.8 (23.2%)	948.4 (11.5%)	46.4 (0.6%)	2.38
2005	8,780.6 (100%)	5,887.2 (67.0%)	1,848.2 (21.0%)	1,002.9 (11.4%)	42.3 (0.5%)	2.45
2006	9,594.9 (100%)	6,476.2 (67.5%)	1,905.2 (19.9%)	1,173.9 (12.2%)	39.7 (0.4%)	2.58
2007	10,355.8 (100%)	7160.2 (69.1%)	1,895.1 (18.3%)	1,262.5 (12.2%)	38.1 (0.4%)	2.62

Source: National Science Council. 2008. *Indicators of Science and Technology 2008.* http://www.nsc.gov.tw/tech/pub_data_main.asp
Note: The currency exchange rate is about US$ 1 to NT$ 32.

Table 17.16: Taiwan R&D expenditure by Business sector is above 62.8% [173]

Chapter 18: Drivers of Innovation Ecosystem of USA, China & Israel: Defense-R&D Driven, Universities became An Integral Part of Military Ecosystem

The route adopted by of USA, China and Israel are altogether different. There Universities are involved in Defense R&D projects and thus playing role of industry too.

During World War II, the U.S. mobilized scientists in a way ***no other country had****.* ***For 45 years – post World War II until the fall of the Soviet Union*** *– the U.S. viewed science and technology as a strategic asset. They made major investments in it, understanding that establishing basic and applied science leadership was necessary for us to build advanced weapons systems to defend our country and deter and if necessary, wage and win a war with the Soviet Union. These investments took the form of building national research organizations, several for basic science (NSF, NIH) and others for applied weapons research (DOD, DARPA, DOE, etc.)* ***Research universities also became an integral part of the military ecosystem*** *as the federal government pumped billions into supporting science. Startups,* ***entrepreneurship and commercial applications are happy byproducts of those military investments****. [221] [224]*

Israel has a great innovation power and R&D culture in the country. In Israel, there are almost 300 R&D centers and 50 % of world's biggest technology companies have an R&D center there. Some quite staggering fact was that as much as 18 % of Israel's GDP comes from R&D centers foreign firms have placed there. [668]

*The government also does not offer any incentives to startups, unlike in Israel where startups developing technology for national security or defense receive government support and subsidies. "****In Israel, companies initially need to provide their technology exclusively for defense, but later are allowed to exploit it commercially****," Vishwanath Alluri, a startup entrepreneur and chairman and CEO of IMImobile, told ZDNet Asia. [680]*

18.1. USA

18.1.1. US Innovation: By Product of Military Investments

The rise of the U.S. **innovation system** in the second half of the 20th century was profoundly tied to U.S. World War II and Cold War defense science and technology investment. However, this late 20th century **military technology evolution was only part of a much bigger picture of innovation transformation**…Governmental science and technology organization in the U.S. largely dates from WWII and the immediate post-war. As suggested earlier, technology evolution in this country comes from a kind of "Push Me-Pull You" relationship **between civilian economic and defense sectors**, and WWII was a transformative period where the **pressure for military technology** advance later led to a dramatic economy-wide advance. [227]

During World War II, the U.S. mobilized scientists in a way no other country had. **For 45 years – post World War II until the fall of the Soviet Union** – the U.S. viewed science and technology as a strategic asset. They made **major investments** in it, understanding that establishing basic and applied science leadership was necessary for us **to build advanced weapons systems** to defend our country and deter and if necessary, wage and win a war with the Soviet Union. These **investments took the form of building national research organizations**, several for basic science (NSF, NIH) and others for applied weapons research (DOD, DARPA, DOE, etc.) **Research universities also became an integral part of the military ecosystem** as the federal government pumped billions into supporting science. **Startups, entrepreneurship and commercial applications are happy byproducts of those military investments.** [221] [224]

America's pre-eminence in both scale intensive industries and in science based and in high technology industries following the Second World War were the result of an unusual set of circumstances. [225]

- First, significantly before World War II U.S. industry had taken the lead in a number of industries where economies of scale and scope were significant (like steel, sewing machines, and later automobiles.). The reason was that the U.S. then was by far the world's largest "common market." With the opening of trade after WWII and the significantly lower costs of transport, even firms in small countries could take advantage of large markets and operate at scale. [225]
- Second, World War II devastated the economies that had been strong competitors for technological leadership prior to the war. Prior to the war, Germany was the leader in many fields and Britain was in a few. The war severely damaged much of the German scientific establishment. The magnitude of U.S. postwar finance of science and new technologies helped the U.S. overtake the British. [225]
- Third, **after the Second World War, the U.S. pioneered in large-scale public finance of university-based scientific research as well as large-scale government support of the development of high tech industries related to defense and space. This is the era in which the United States took the lead in many high technology industries.** Political support for these programs in the U.S. depended to a good extent on our sense of being **challenged and threatened by the Soviet Union**. By the end of the 20 Century two things had changed. One

was that other countries were greatly **expanding their own finance of university science**. The other was that the **end of the cold war eroded the political support for programs to support and grow high technology industries in the United States**. [225]

18.1.2. US Innovation Ecosystem

America's innovation system also is **extremely complex**. It is characterized by myriad varieties of interactions among

- Government agencies
- Universities
- Private industry
- Financiers, and
- Intermediary organizations.

The system is fed by research-and-development spending that still far exceeds that of any other nation. The innovation system is supported by the world's best university system and deepest pools of private angel and venture investment capital. [225]

The report of the Group of Eight (Go8), Coalition of Leading Australian Universities stated that "According to one estimate, only **125 universities contributed in 'meaningful ways'** to the growth of knowledge; and the **skewed distribution of research activity** even within this group meant that a small number accounted for a very high proportion of the discoveries that flowed from university research within the USA. For example, in 2001 the **top 200 universities accounted for around 96 per cent** of all higher education research expenditures; the top 100 institutions received 51 per cent of the total public funding for academic research and the top 20 about 20 per cent." [294]

18.1.2.1. Strong Protection of Intellectual Property

Strong protection of intellectual property rights, business-friendly bankruptcy laws, a flexible labor force, and an entrepreneurial culture and legal system that favor risk-taking and tolerate failure are among the framework conditions that have kept the U.S. at the forefront of innovation. Since passage of the **Bayh Dole Act of 1980**, which made it easier for universities to sell and license technology generated from federally funded research, the role of research universities in starting new high-tech companies and commercializing technology has increased dramatically. [225]

18.1.2.2. Global Talent

Another crucial American advantage has been its **openness to foreigners**. Scientists fleeing European fascism helped develop atomic energy in the U.S. and spurred its post-War ascendance in natural sciences. An influx of top talent from Taiwan, India, South Korea, China and other regions and nations who came to the U.S. to study and then settled were instrumental in U.S. pre-eminence in industries such as semiconductors, computers, software, and biotechnology. **Foreign-born talent also has accounted for a disproportionate share of U.S. high-tech start-ups**. [225]

18.1.2.3. Federal Funding of Research

At the front end of America's innovation system is basic research that is **largely funded by the federal government and carried out by research universities**. In contrast to many other nations, civilian research spending by the federal government is not coordinated by a single agency but instead distributed among a large number of mission agencies and departments. **The Department of Defense accounts for a little over half of federal R&D.** [225]

18.1.2.4. Research Universities

Research universities are the engines of the U.S. innovation system. Of these, the nearly 200 public research universities conduct more than 60 percent of federally funded basic research. [225]

18.1.2.5. National Laboratories

While **defense contractors and other private companies receive the lion's share of federal R&D dollars for applied research and development**, the U.S. also has 37 federally funded research and development centers, 16 of which are national laboratories sponsored by the Department of Energy (DOE). Other research centers are sponsored by the armed forces and agencies such as the Department of Homeland Security, the National Science Foundation, the Department of Health and Human Services, and the Internal Revenue Service. National laboratories focus on critical national needs such as defense, energy security, and space flight, **but have been increasing their roles as partners with private industry**. The DOE's four biggest national laboratories—Los Alamos, Lawrence Livermore, Sandia, and Oak Ridge— and NASA's Jet Propulsion Laboratory together **account for 55 percent of the $20 billion of U.S. funding** for federally funded R&D centers. In addition to awarding research grants in response to proposals, federal agencies also operate a number of **mission-specific programs devoted to accelerating development of high-priority technologies through public-private partnerships with industry and academia**. The DOE, for example, **awards grants to companies and universities** to accelerate development of specific technologies relating to advanced batteries, electric-drive vehicles, and photovoltaic cells. The Technology Innovation Program, supervised by NIST, was designed to fund high-risk research addressing critical national needs, such as sensors for monitoring civil infrastructure, Nano-scale materials, and advanced manufacturing processes for electronics, and genetic engineering. The National Cancer Institute at the NIH funds research into cures and treatments for diseases such as bladder, breast, colon, and kidney cancer. **Federal programs aimed at disseminating technology to the private sector** include the Hollings Manufacturing Extension Partnership of the Commerce Department. [225]

18.1.2.6. Private Sector

The **innovation process itself—that of developing marketable products—has traditionally been the realm of the U.S. private sector.** Private industry over the past six decades has assumed an ever-greater share of U.S. R&D spending, and now **accounts for around two-thirds. Corporate R&D funding has increasingly concentrated on development**, as opposed to basic and applied research. More than 70 percent of that private investment is devoted to product development and another 20 percent or so to applied research. The federal government, in fact, has long played a much bigger role in the U.S. innovation system than many assume. [225]

18.1.2.7. Public-Private Partnerships

Public-private collaborations have been woven into the fabric of the U.S. economic system since the early days of the republic. The **armed forces, recognizing that innovation is critical to national defense**, have played an instrumental role in funding and procuring platform technologies such as airframes and engines, satellites, semiconductors, computers, the global positioning systems, nuclear energy, and the Internet. **Technology for national defense and economic growth are both part of the same innovation system**. [225]

The military's involvement in U.S. innovation goes far beyond funding R&D projects. For decades, the Defense Advanced Research Projects Agency (DARPA) has helped orchestrate collaborations and social networks among researchers and industry that have identified new technology trends and developed broad technology platforms that cut across industries. [225]

Federal agencies also have been more important to the funding of U.S. technology start-ups than many assume. The Small Business Innovation Research (SBIR) and other federal programs provide up to one-quarter of early-stage technology funding. Importantly, these federal efforts are often successful. Some **two-thirds of award-winning inventions** honored by R&D Magazine stem in part from **partnerships between government and business.** [225]

Companies like Apple and FaceBook flourish without direct government help, their innovations would not have been possible without previous federal investments in the Internet, computers, and semiconductors, not to mention in the university systems that produced their technology talent.

Today, the armed forces have a major interest in accelerating development of technologies that conserve energy and reduce dependence on fossil fuel, which they regard not only as important to future weapons systems that can provide strategic advantage in the battlefield but also can reduce America's dependence on distant nations for energy. [225]

18.1.3. US 10-year National Innovation Strategy

The U.S. Congress in late 2010 asked the Department of Commerce to complete two studies as part of the reauthorization of the America COMPETES Act.

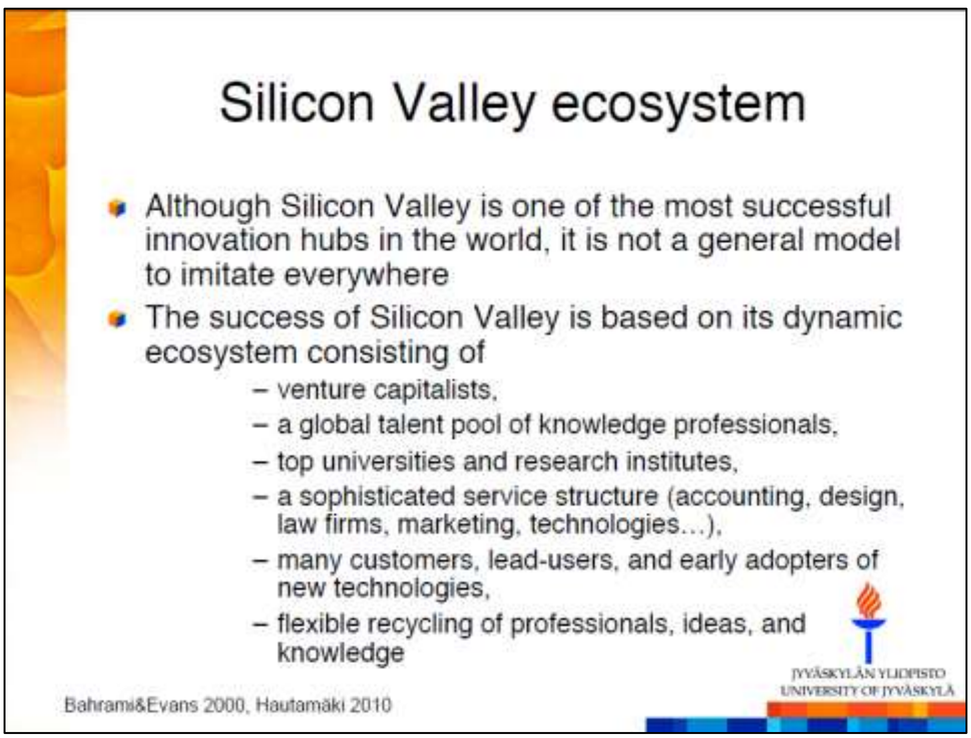
- The first, which was released on January 6th, **2012**, at the Center for American Progress, focuses on U.S. competitiveness and **innovation**.
- The second, due to Congress in early **2013**, offers specific recommendations for developing a **10-year national innovation** and competitiveness strategy. [9]

Fig. 18.1: US Report: Universities in Innovation Networks [9]

In the context of the declining state of innovation in the United States, we have an opportunity to tap into universities in a variety of ways, among them:

- **Stoking the engine of innovation**—supporting university research, the foundation for the most groundbreaking innovations and innovators that can create new industries
- **Supporting the flow and application of knowledge**—bringing industry expertise to academia and reducing scientific risk to enable early discoveries to advance to the stage where the private sector is willing to invest and capitalize on them
- **Seeding innovation ecosystems**—creating the culture, human capital, and connections necessary to form innovation networks where researchers, entrepreneurs, investors, manufacturers, and other research interests can collaborate and compete
- **Measuring for success**—developing the right framework and infrastructure for measuring innovation to guide policymaking and investments
- **Preparing for shifts in competitiveness**—rethinking assumptions and trying new approaches so that policy can drive new frontiers of innovation [9]


THE US INNOVATIONS PARADIGM
In the last 50 years several major scalable innovations originated in the US:
Transistor, Laser, Fiber optics, Micro Processor, Windows, DNA, Genetics…
US provided the ecosystem to breed ideas:
Large talent pool, Young diverse talent,
Risk capital, Government Funding, Autonomy, Markets,
Flexibility, Rule of law, IP framework etc.
Silicon Valley has been the source of many innovations


Silicon Valley ecosystem
Although Silicon Valley is one of the most successful innovation hubs in the world, it is not a general model to imitate everywhere
The success of Silicon Valley is based on its dynamic ecosystem consisting of
– venture capitalists,
– a global talent pool of knowledge professionals,
– top universities and research institutes,
– a sophisticated service structure (accounting, design, law firms, marketing, technologies…),
– many customers, lead-users, and early adopters of new technologies,
– flexible recycling of professionals, ideas, and knowledge
JYVÄSKYLÄN YLIOPISTO
UNIVERSITY OF JYVÄSKYLÄ
Bahrami&Evans 2000, Hautamäki 2010

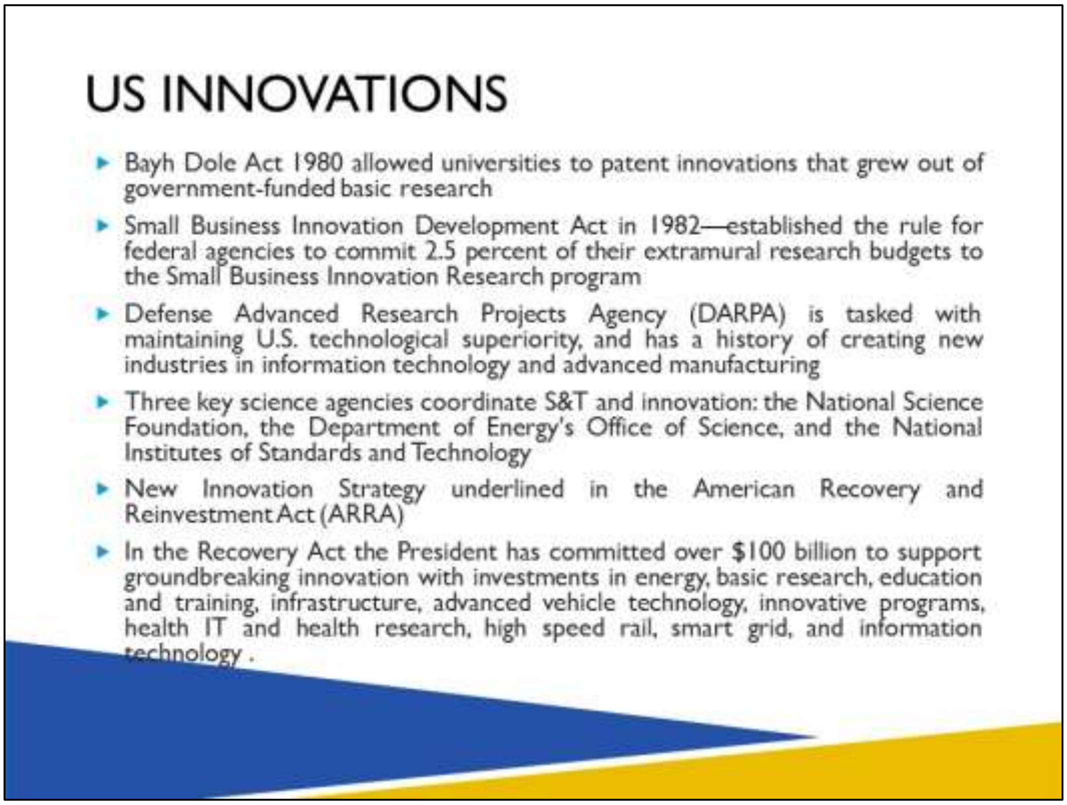


Fig. 18.2: Source of US Innovation: Silicon Valley [218] [223]

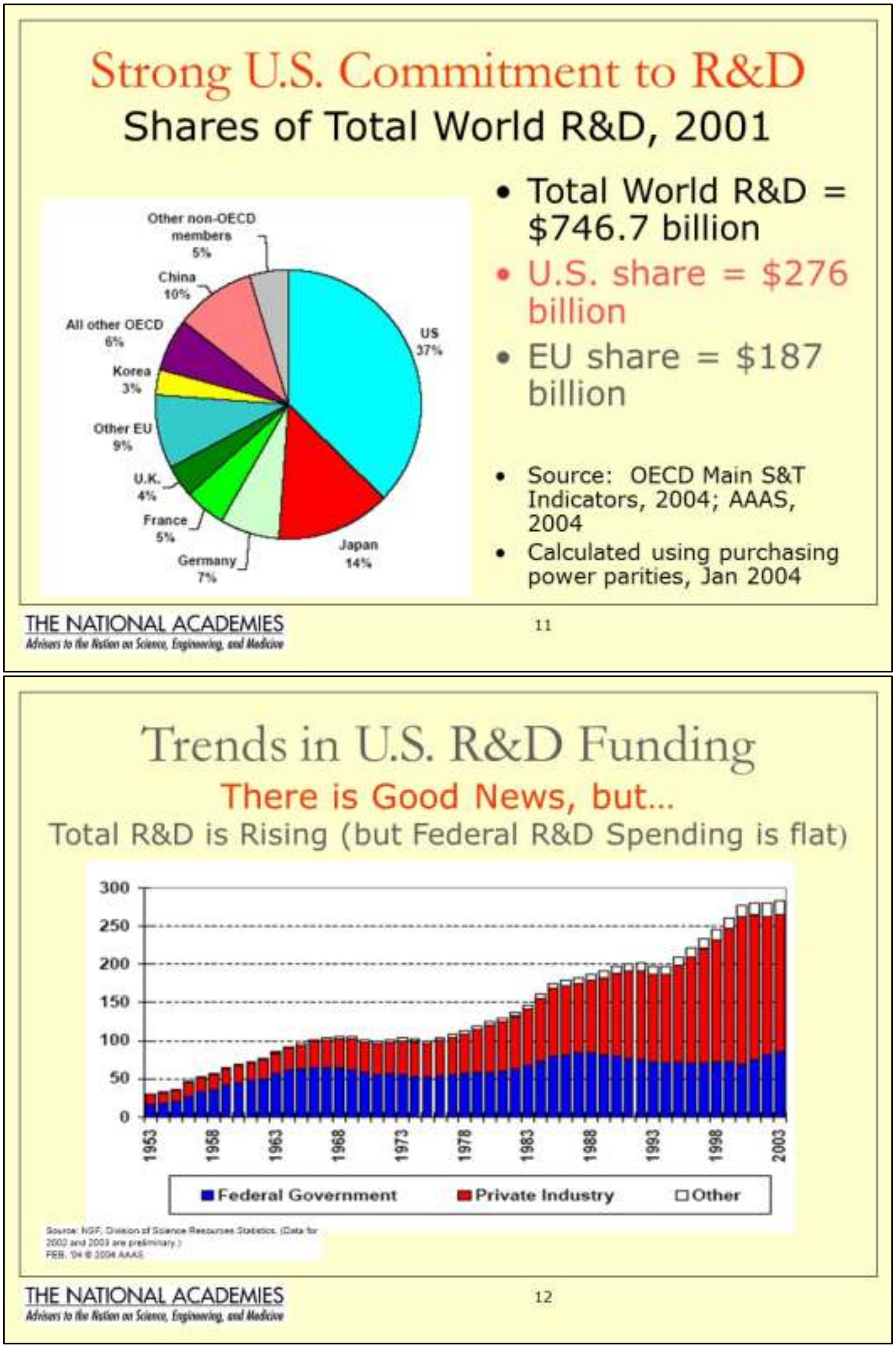


Fig. 18.3: US R&D expenditure [219]

18.2. China

China is leveraging its enormous talent pool, domestic market, foreign investment, and mounting wealth to make significant progress in growing technology-intensive industries. China has doubled its share of **global R&D spending from 6 percent in 1999 to 12 percent in 2010**. [225]

Over the last three decades, to achieve strategic parity with the United States and to construct a modern military, the Chinese have made massive investments in building their science and technology infrastructure… China's military modernization depends heavily on investments in China's science and technology infrastructure, reform of its defense industry, and overt and covert procurement of advanced technology and weapons from abroad. [221]

In short

- China is working to build basic and applied science and technology leadership
- Like the U.S. and the Soviet Union in the Cold War they are using science and technology to build advanced weapons systems
- **Technology startups are a side effect from these investments** [221]

The Torch Program

In size, scale and commercial results China's Torch Program from MOST (the Ministry of Science and Technology) is the most successful entrepreneurial program in the world. Of all the Chinese government programs, the Torch Program is the one program that kick-started Chinese high-tech innovation and startups. In the last decade Torch managed to break free of China's state central planning bureaucracies. Of all the Chinese innovation programs, Torch is the one that was run like a startup – iterating and pivoting as it learned and discovered. This enabled Torch to evolve with China's rapidly global economy. Torch has four major parts:

- Innovation Clusters
- Technology Business Incubators (TBIs)
- Seed Funding (Innofund)
- Venture Guiding Fund [221]

The Torch program created Innovation Clusters by creating

- National Science and Technology Industrial Parks (STIPs)
- Software Parks, and
- Productivity Promotion Centers [221]

The first Science and Technology Industrial Park was "Zhongguancun Science Park in Beijing". It has become China's Silicon Valley. In addition to the one in Beijing, China has set up 53 additional industrial parks and in them are ~60,000 companies with 8 million employees. Industry or technology specific versions of these clusters have been set up…The Science and Technology Industrial Parks contributed 7% of China's GDP and close to 50% of all of China's R&D spending. Another key part of China's cluster strategy was collaboration between research and business, as well as between large enterprises and tech-based small and medium enterprises. It did so by building a national network of a 1,000+ Productivity Promotion Centers. They provide consulting, promotion, product testing, hiring, training and incubation services to startups…By 2011, there were a total of 1034 Technology Business Incubators across China, including 336 as National incubators, hosting nearly 60,000 companies... China has the biggest Venture Capital industry outside the U.S [221]

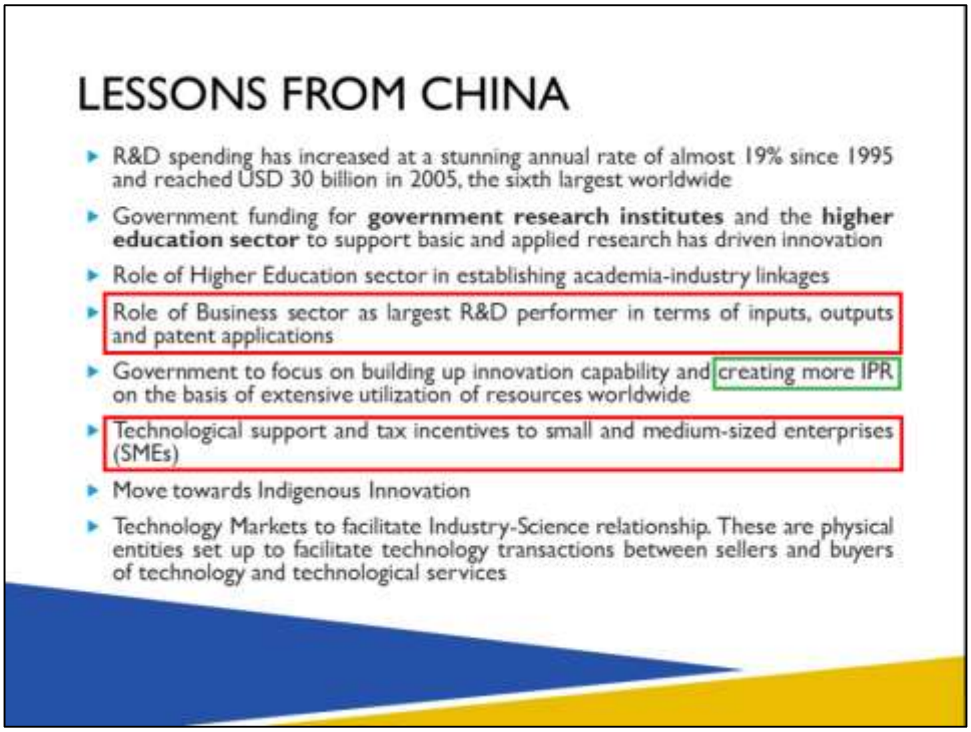


Fig. 18.4: Innovation: Business Sector is the Largest R&D performer, IPR and SME [218]

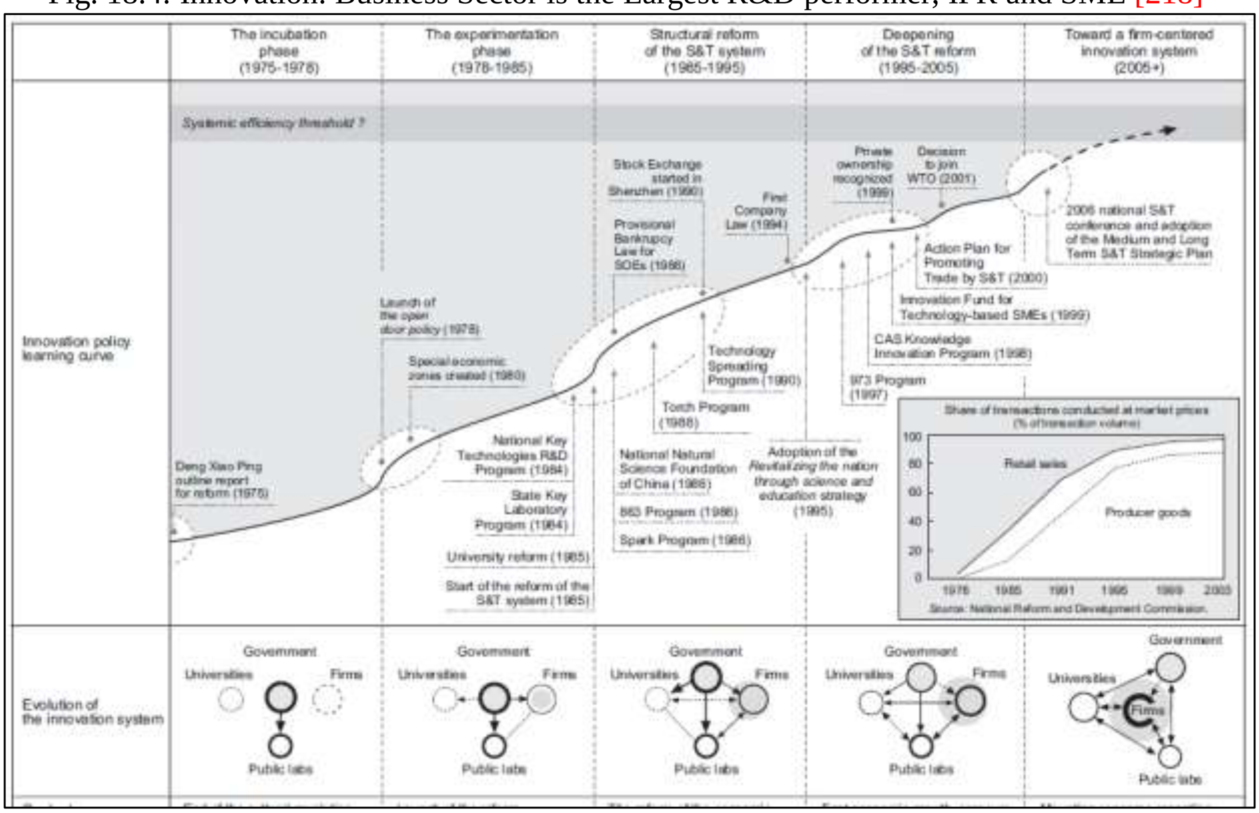


Fig. 18.5: China's Innovation Policy (part of the diagram) [222]

18.3. Israel: Significant Impacts by Defense-Related R&D

Israel is a remarkable performer when it comes to innovation. The Israeli private sector spends more on innovation as a percentage of GDP than that of any other nation. [176]

Fig. 18.6: Israel: Global Leader [216]

When viewed in historical perspective, there can be little doubt that the **defense sector in Israel had a fundamental impact on the development of this country's technological and industrial capabilities**. For most of its first 50 years, Israel devoted a large share of its resources to defense purposes, putting a high priority on the development of modern armed forces with sophisticated military technologies and equipment, and on the ability to develop and supply these capabilities by its own means. **Derived demand from this buildup for highly skilled workers, scientists and engineers affected public resources allocated to universities and research institutions**, and accordingly the directions that these institutions emphasized as they expanded. Israel has today a concentration of scientists and engineers in its work force which is among the highest in the world, and a rate of high-tech startups which is high among industrialized countries even in absolute terms. The defense manufacturing industry in Israel accounts for a significant share of its industrial capacity, includes some of its largest corporations, and is considered a major worldwide player in some areas of the defense industry. [177]

When evaluating Israel's high-tech capabilities and impressive economic achievements since inception, it is difficult not to recognize the **important role played by defense and military developments**. In particular, **defense-related R&D had significant impacts** on, as much as it was aided by, Israel's industrial sector, higher educational system in science and engineering, research community, and the composition of its work force. [177]

Furthermore, **defense industries in Israel led its industrial sector in R&D and high-tech intensity** through most of the first 4 decades of its existence. It was estimated that during the 80's, **65% of the national expenditure on R&D were defense related**, while only **13% were oriented towards civilian industries**. About **half the scientists and engineers** employed in the industrial sector worked in defense industries. [177]

Defense industries in Israel amount to a significant part of the country's industrial capacity, and are big even in international terms. Dan & Bradstreet's 1997 listing of the largest industrial 150 corporations in Israel, (in sales), included 10 firms in the defense sector, as were 2 of the largest 5, (and 3 of the largest 30, if RAFEL, which is not incorporated , were included). Five Israeli companies appear in the list of the 100 biggest defense companies in the world, (Israeli Aircraft Industries, RAFAEL, Koor Industries, Tadiran, and Elbit Systems). The **defense industry accounts for about 25% of industrial output in Israel**, and about 20% of total employment in the industrial sector. [177]

Israel's innovation laurels are several
- Highest gross expenditure on R&D
- Largest amount of companies listed on NASDAQ outside of North America
- Highest level of venture capital as share of GDP, etc.

How did this success come about? [151]

According to Israeli venture capitalist Dr. Orna Berry "The Israeli government made a crucial strategic decision to jump start a science based sector by providing **financial support for commercial R&D**". [151]

R Chandrasekharan, Executive Vice Chairman of Nasdaq-listed Cognizant Technology Solutions said that "In Israel, there are various external factors which are compelling the country to **aggressively focus on innovation**, especially in areas of **defense and aerospace**. I think, a **Indian companies are now slowly realizing the importance of the external factors and innovating**."[439]

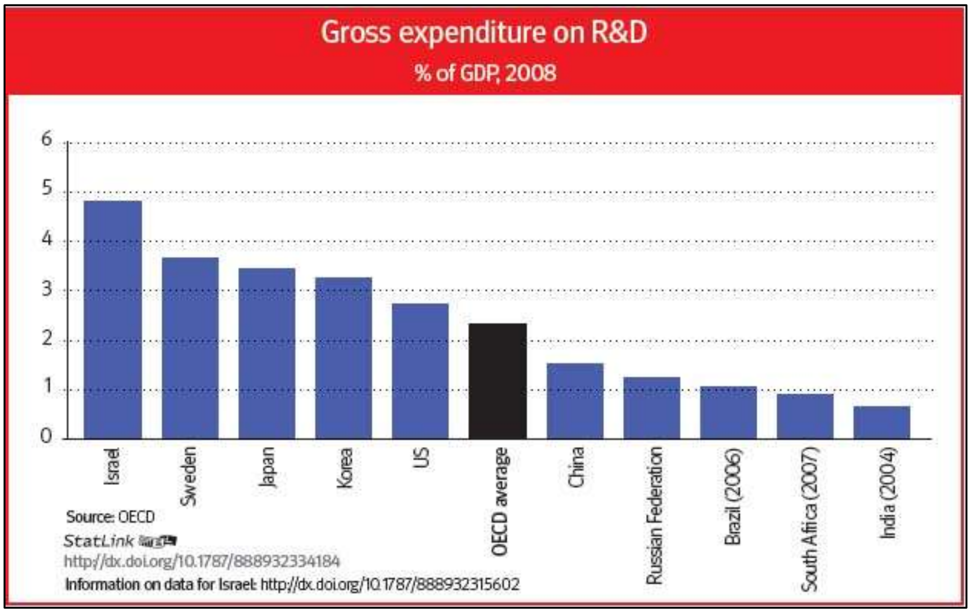


Fig. 18.7: Israel R&D investments [151]

It was the emergence of Israel's export based high-tech sector in the early 1990s that really put the country's economy on track, with GDP growth of at least 4% a year. Specializing in computer hardware and software, medical technologies and pharmaceuticals, this sector became world-renowned for innovation. Flash drives, cardiac stents, instant messaging and shopping.com are only a few of Israeli-bred innovations that have emerged in the last few decades. High-tech industries represent almost 50% of total industrial exports today, according to OECD data. **Between 1995 and 2004, Israel increased its spending on R&D, calculated as a percentage of GDP, from 2.7% to 4.6%, a rate higher than any OECD country**. [151]

Israel certainly had the human capital by the early 1990s to fuel the boom. Israel's compulsory military service provides early training in sophisticated technologies. Furthermore, the country saw the influx of almost one million ex- Soviet Jewish immigrants in the 1990s. These highly educated immigrants, whose ranks included 82,000 Russian-trained engineers, assimilated into the local labor market, providing key scientific and IT skills. The Jewish diaspora also provided a large pool of researchers. [151]

Israel has the highest density of tech start-ups in the world. More importantly, these start-ups attract more venture capital dollars per person than any country — 2.5 times the U.S., 30 times Europe, 80 times India, and 300 times China. Israel has more companies on the tech-oriented NASDAQ than any country outside the U.S., more than all of Europe, Japan, Korea, India, and China combined. But it's not just about start-ups. Scratch almost any major tech company — Intel, Microsoft, Google, Cisco, Motorola, and so on — and you will find that Israeli talent and technology play a major role in keeping these multinational companies on the cutting edge. [171]

Israel's innovation system is a key driver of economic growth and competitiveness. While the success of the **Israeli system is primarily attributable to vibrant business sector innovation and a strong entrepreneurial culture**, the government has also played an instrumental role in financing innovation, especially in SMEs, and in providing well-functioning framework conditions for innovation, including venture capital (VC), incubators, strong science industry links, and quality university education. For example, Israel reportedly has around 70 active VC funds, which raised EUR 963 million in 2005 and EUR 437 million in 2006. It has 24 technology incubators, 16 of which are privately owned. [174]

Fig. 18.8: Israel: Innovation Ecosystem [216]

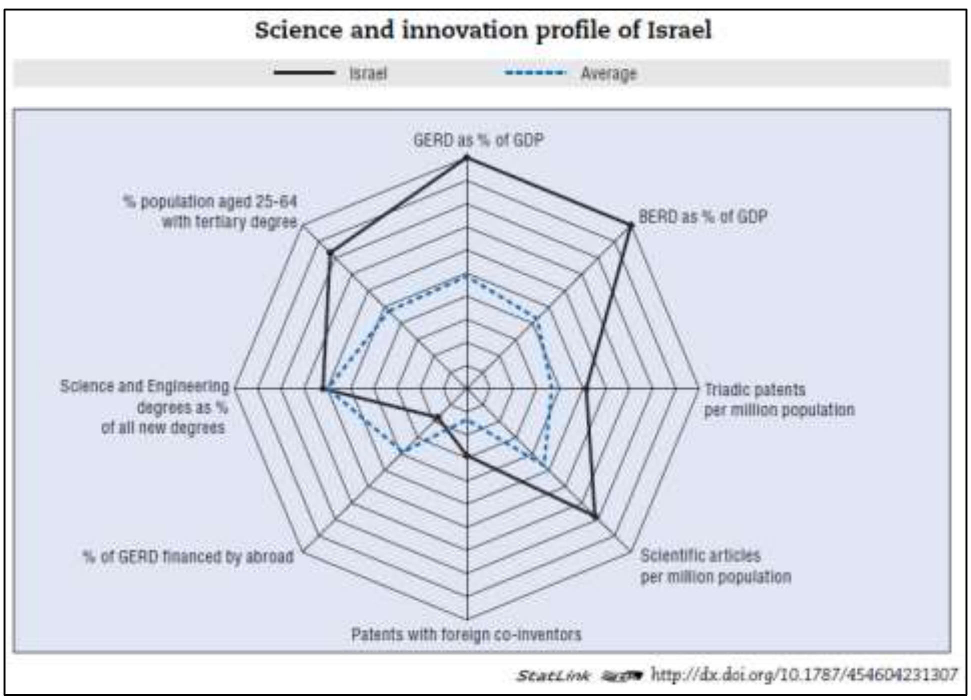


Fig. 18.9: Israel: Innovation Profile (BERD: Business-Enterprise Expenditure on R&D, GERD: Gross Expenditure on R&D) [174]

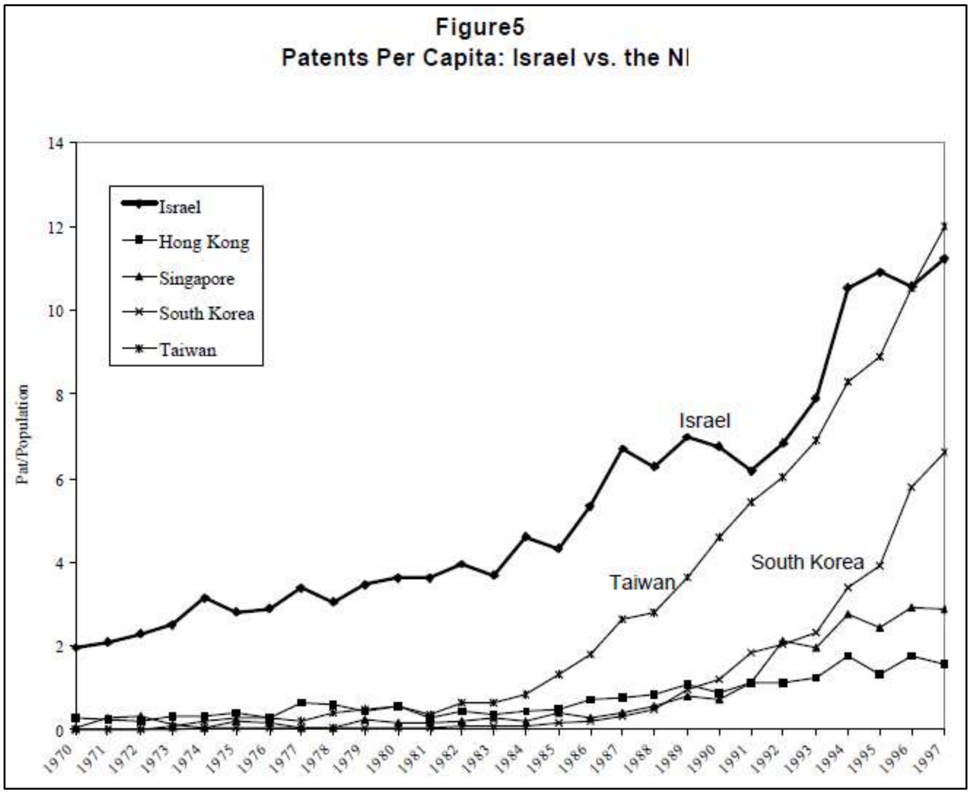
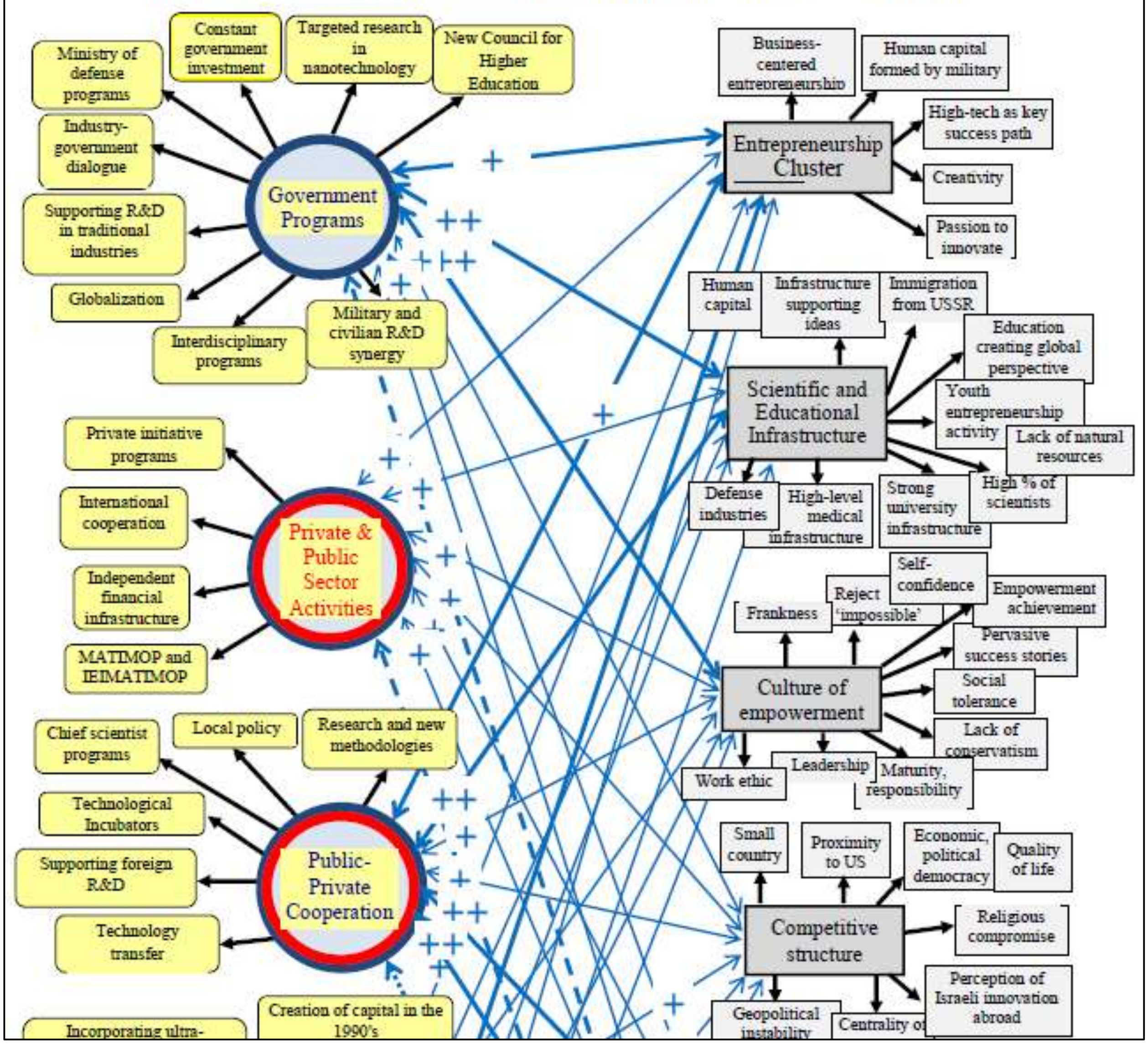


Fig. 18.10: Israel vs 4 Tigers of Asia: Patents per capita [175]

The case of Israel is altogether different than other cases.

Figure 4: Detailed Innovation Map for the Israeli Ecosystem



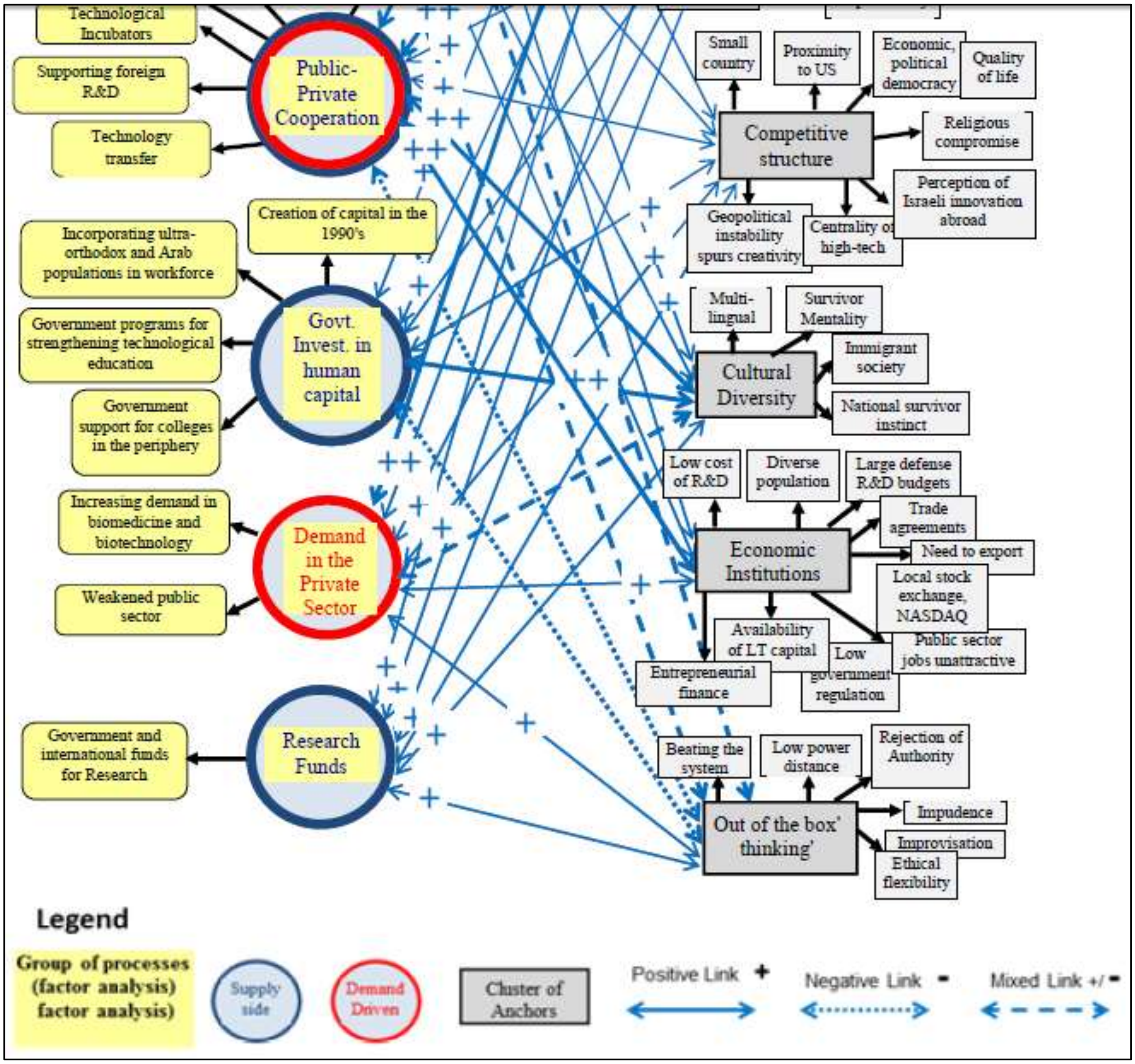


Fig. 18.11: Innovation Map of Israeli Innovation Ecosystem [670]

Chapter 19: Drivers of Innovation Ecosystem of Singapore: Driven by MNC-R&D

During 1960s and 1970s, facing the scarcity of natural resources, Singapore directed the industrial policies towards employment-creation, using ***favorable incentives to attract foreign direct investment and multi-national companies (MNCs) to increase productive capacity****. Gradually, a vibrant manufacturing sector was formed and dominated the economy. Unlike other "Asian Miracles", Singapore* ***primarily relied upon MNCs*** *to produce the knowledge spillovers and technology transfers necessary to develop its national technological capability rather than indigenous R&D. [173]*

19.1. Singapore: R&D is Promoted through MNC & then Shifted Emphasis to Private Sector

Under the small-open economic framework, as a market price-taker Singapore government has adopted strong interventions in labor, land, and industrial development to ensure its transition from a third-world to a first-world country. During 1960s and 1970s, facing the scarcity of natural resources, Singapore directed the industrial policies towards employment-creation, using **favorable incentives to attract foreign direct investment and multi-national companies (MNCs) to increase productive capacity**. Gradually, a vibrant manufacturing sector was formed and dominated the economy. Unlike other "Asian Miracles", Singapore primarily **relied upon MNCs to produce the knowledge spillovers and technology transfers necessary to develop its national technological capability** rather than **indigenous R&D**, for example, the initial intention of the government to establish a Singapore Science Park was to attract Foreign Direct Investment (FDI) and MNCs. But past experiences show that such over-reliance on FDI and MNCs had constrained the country's ability to resist external economic crisis as global competition intensifies. Thereafter, Singapore began the pursuit of sustainable economic growth through promoting entrepreneurship and raising the quality of indigenous human capital to international standards (Tan 2003). In 1989, Singapore government created the first Small and Medium-Sized Enterprise (SME) Master Plan to introduce measures and assistant schemes for SME development and to improve entrepreneurial infrastructure. Moreover, entrepreneurial mindset was introduced in civil services through the Public Service for the 21st Century in 1995; a deliberate exercise aimed at nurturing entrepreneurial attitude of excellence and fostering an entrepreneurship-friendly environment in the public service. In 2000, the Enterprise Challenge (a branch under the Prime Minister's Office) even set up a S$10 million fund to sponsor innovative projects which may improve the provision of public service. Hit by the 1997 Asian financial crisis, the government released the second Master Plan (SME21) in 2001, calling for urgency to inspire entrepreneurship yet again in Singapore. Meanwhile, it also actively promoted spending in the private sector through various incentives. [173]

Since the implementation of its National S&T Plans in the early 1990s, the **government has shifted the emphasis of R&D research to the private sector**, reflected by the over-proportionate R&D funding to the private sector. From 1997-2007, the private sector consistently occupied over 60% of the total national R&D funding, while the HE sector only accounts for 10%-13% of these amounts, and shown a slight decline since 2003:

As a small city-state with little endowment of natural resources, Singapore faces immense pressure in tackling challenges posed by globalization and knowledge economy. **Since the 1990s, it began to develop its higher education as a globally tradable export service**, with the ambition to forge itself a regional hub of education which could also contribute to its economic growth. [173]

Now Singapore is investing aggressively to build an "**innovation-driven economy**." Among other things, Singapore is investing some $10 billion in a network of research parks in a 500-acre urban district called One North. They include Biopolis, a 4.5 million-square-foot campus housing 5,000 life science researchers from universities, hospitals, and multinationals such as Eli Lilly and Novartis, and Fusionopolis, a futuristic 24- story tower filled with media, communications, and information technology companies. [225]

Table 60. Singapore National R&D Expenditure by Sector (1997-2007)

Year	R&D Expenditure by Sector (in US$ Million)									
	Total National (TNE)		Government Sector		Public Research Institutes		HE Sector		Private Sector	
	S$	% of GDP	S$	% of TNE	S$	% of TNE	S$	% of TNE	S$	% of TNE
1997	1,501	1.5	154	10.27	211	14.07	198	13.21	938	62.5
1998	1,778	1.81	214	12.04	250	14.09	218	12.28	1,096	61.64
1999	1,895	1.9	218	11.48	265	13.97	221	11.67	1,192	62.91
2000	2,147	1.88	302	14.09	272	12.66	241	11.23	1,331	61.99
2001	2,306	2.11	303	13.15	283	12.25	262	11.35	1,459	63.25
2002	2,429	2.15	320	13.19	310	12.75	307	12.63	1,492	61.41
2003	2,443	2.11	311	12.73	321	13.14	327	13.37	1,485	60.76
2004	2,897	2.2	315	10.88	432	14.9	303	10.47	1,848	63.78
2005	3,269	2.3	316	9.67	449	13.75	341	10.43	2,162	66.15
2006	3,574	2.31	370	10.34	444	12.44	411	11.5	2,349	65.73
2007	4,522	2.61	550	12.16	521	11.52	430	9.51	3,021	66.81

Source: A*STAR, Singapore National Science and Technology Survey (various years).
Note: Taking the currency exchange rate of 25th Jan for analysis, which was about US$ 1 to S$ 1.4017.

Table 19.1: Singapore: National R&D expenditure in Private sector is above 61.4% [173]

19.2. Comparison of South Korea, Singapore, Japan, Taiwan and Hong Kong

Hong Kong's universities are heavily funded by the government. Over the last decade, the government has become eager to develop the city-state into an education hub, both in terms of academic and research. Hong Kong universities are vital to the overall innovation system since they are the largest R&D spender. In this respect, the government is concerned about the way how taxpayer money can be used effectively. [173]

Table 31. R&D Expenditure by Performing Sector, (2003-2007)

Sector	R&D Expenditure (US$ million)				
	2003	2004	2005	2006	2007
Business	454.5 (41%)	588.5 (48%)	720.7 (51%)	806.1 (53%)	776.2 (49%)
Higher Education	614.9 (56%)	603.5 (50%)	651.9 (47%)	693.7 (45%)	776.5 (49%)
Government	26.6 (2%)	26.6 (2%)	27.6 (2%)	31.9 (2%)	37.9 (2%)
Total Expenditure	1,096.0 (100%)	1,218.6 (100%)	1,400.2 (100%)	1,531.7 (100%)	1,590.7 (100%)
Total R&D Expenditure as Share of GDP	0.69	0.74	0.79	0.81	0.77

Source: Census and Statistics Department. 2009. *Hong Kong Monthly Digest of Statistics*: Statistics on Research and Development of Hong Kong, 2003 to 2007. http://www.statistics.gov.hk/publication/feature_article/B70905FA2009XXXXB0100.pdf.

Table 19.2: Hong Kong: Business & Higher Education are spending equally on R&D [173]

Singapore, Japan and South Korea share a similar pattern that their innovation systems are led by both the state and industry (especially big corporations), yet the three countries also differ in one important aspect, that is the nature of those corporations. In Singapore, the government welcomes foreign investments and companies, sometimes we may even find that the government favors foreign companies in order to attract them to invest in Singapore. But in Japan and South Korea, big corporations are mostly local in nature as they regard local industries as their national strengths, which need to be protected and supported. Therefore, while Singapore is described as a "**technoglobalist**" country, Japan and South Korea can be categorized as "**technonationalist**" countries. [173]

Figure 3. Typology of Triple-Helix network mechanism in five selected countries/cities

	State	Industry	University
Hong Kong	△	○	△
Japan	○	○	△
Singapore	○	○	△
South Korea	○	○	△
Taiwan	○	○	○

Source: Drawn by the author

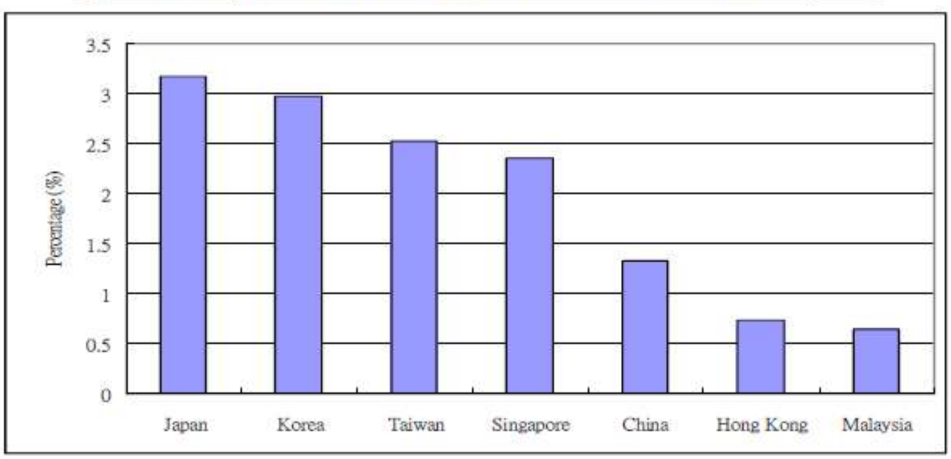
Note:

1. "○": Significant contribution; ""△: Insignificant yet emerging contribution
2. "○" indicates a significant contribution of that stakeholder to the national innovation system, while the absence of "○" does not infer that the stakeholder has no contribution at all; because each of the three stakeholders must has certain impact on the innovation system, though to different degrees. Besides, the indication of "○" of the same stakeholder of different countries does not imply that the degrees of contribution of that stakeholder are the same in different countries.

Table 19.3: Triple-Helix Network of South Korea, Singapore, Japan, Taiwan and Hong Kong [173]

The following Figure compares and contrasts the GERD / GDP for selected Asian societies, it clearly shows Hong Kong has spent the **least in innovation**, while Singapore has tried to catch up and Japan, South Korea and Taiwan have a similar level of GERD / GDP in innovation advancement.

Figure 6. Comparison of GERD/GDP for Selected Asia Countries (2005)



Source: Malaysia National R&D Survey, 2008.

Fig. 19.1: Comparison of Ratio of Gross Expenditure on R & D (GERD) / GDP [173]

In short, all the 6 nations had developed the economy by focusing on Business R&D investments.

Chapter 20: Final Words

"A majority of India's weaknesses arise from the ***absence of an encouraging ecosystem*** *that* ***fuels innovation****. There is really* ***nothing much that supports innovation in India****. Despite the current decade being called* ***India's decade of innovation****, India has been* ***ranked at the bottom*** *of the list of 25 countries in terms of its intellectual property (IP) environment," Richard Rekhy, Chief Executive Officer, KPMG India [233]*

"There is also a huge gap when it comes to providing a supporting environment for innovations and research. ***Indian scientists are doing extremely well overseas****,* ***largely because of the infrastructure and support they receive.*** *It is important that the government, the industry and the academia work in close coordination to leverage existing resources for nurturing manufacturing innovation, thereby creating a robust innovation ecosystem" - Prof. Bhushan Patwardhan, Former Vice Chancellor of Symbiosis International University Pune [63]*

"One of the ***big items on the agenda of corporate India*** *over the next 10-20 years will be* ***innovation****. Indians need to be given "the resource, structure and the process to become innovative". Nirmalya Kumar, Professor, London Business School and a Member of the Group Executive Council at Tata Sons Ltd [506]*

"A ***lack of innovative dynamism*** *has also been noted with regard to the absence of genuinely* ***new global products*** *introduced by Indian companies. Few Indian companies are perceived to have the capacity to innovate disruptive technologies." Prof. Devesh Kapur, Director, University of Pennsylvania. [546]*

20.1. Innovation Scenario of India

According to a World Bank report, India is among the world's leading innovation players in the

- Biotechnology
- Pharmaceuticals
- Automobile parts and assembly sectors of the manufacturing industry. [552]

The article by IFM, University of Cambridge stated that "Indian companies spend **only about 0.3% of their revenue** towards innovation as compared to **3% spent by their counterparts in developed countries**. And although firms in India have been increasingly active in creating new business models, a significant proportion of these **business model innovations have been borrowed from elsewhere** with **very few innovations that are truly 'new-to-world'**. However, it is these new-to-the-world innovations that India needs to develop if it is to achieve sustained economic growth." [556]

The status of overall Indian Innovation Ecosystem is not very encouraging. Let's summarize the analysis of India's Innovation Ecosystem presented in this book.

- The IPR Culture is missing. The scenario is slowly changing after 2005 IPR legal modifications.
- Major Innovation is coming from National Laboratories like Defense, Space, Missile, Nuclear laboratories, which can't be patented due to national security considerations. From national security point of view this research is very important but having little impact on GDP Growth of the nation.
- The huge indigenous market diverts the focus of Indian Industries towards Cost Benefits for growth. The Indian industries couldn't yet adopt the innovation based approach for growth like Tata Group of companies. The Industrial R&D expenditure is less than 1% and the Indian GDP Innovation Contribution is not like USA.
    - The Automobile sector is doing good job and initiated Innovation and Patent activities.
    - Pharmaceutical Industry is doing wonderful job but could not manage to initiate the Patentable research work.
- The National Organizations have collected more than 2 Lakh ideas of Frugal Innovations. But couldn't convert even 1% ideas into International Patents and could initiate very few Startup Companies.
- The failure of National Innovation Ecosystem promoted the "Jugaad" culture. We need effective ecosystem to tap this innovative brains involved in "Jugaad" and convert these ideas in to frugal innovation. The current mechanism is not effective.
- Higher Education and University system is involved in R&D but unable to develop the Patent Culture because of the IPR laws. Without IPR Regime and motivation, this sector can't be activated. Nobody expects that University should play a leading role in Innovation because innovation happens at a point of production or business. But everybody expect that at least they should come out from Mass Education Framework and move towards developing innovation culture.
- The patent contribution of MNC R&D is higher than rest of India but they are working for their own company and nation.
- India is developing extremely good Innovation, S&T and Industrial policies but unable execute it because of legislative paralysis, poor governance and constraints of democracy.

Jack Welch, former CEO, General Electric stated that "**India is a developing country with the scientific and technological infrastructure of a developed nation**."

India suffers from inefficiency in transforming its S&T investments into scientific knowledge (publications) as well as into commercially relevant knowledge (patents). [508]

The DST & Thomson Reuters Report 2012 stated that "**India has been the 'sleeping giant' of Asia**. Research in the university sector, stagnant for at least two decades is now accelerating, but it will be a **long haul to restore India as an Asian knowledge hub**." [509] 110]

India is doing well with process innovation - from Dabbawalas that reached the Harvard Business School to Devi Shetty's low cost heart surgeries that won this year's Economist Innovation prize. We will see now more science-based innovations. [475]

20.2. STI & Innovation Policies: Limited Impact on Inclusive Growth

India is following Inclusive Innovation Model in which affordability is prime consideration and giving importance to Frugal Innovations.

OECD Advisory Group Meeting report stated that "India's STI policies and instruments in the last couple of decades have had **limited impact on inclusive goals and development**. It has been observed that the STI policies under globalization led to considerable growth but increased income and at the same time inequality in income among different sections of society." [231]

Fig. 20.1: Presentation by Secretary, DST, Government of India (2011) [232]

Fig. 20.2: Presentation by Sam Pitroda, Former advisor to PM India: India Innovation Decade [217]

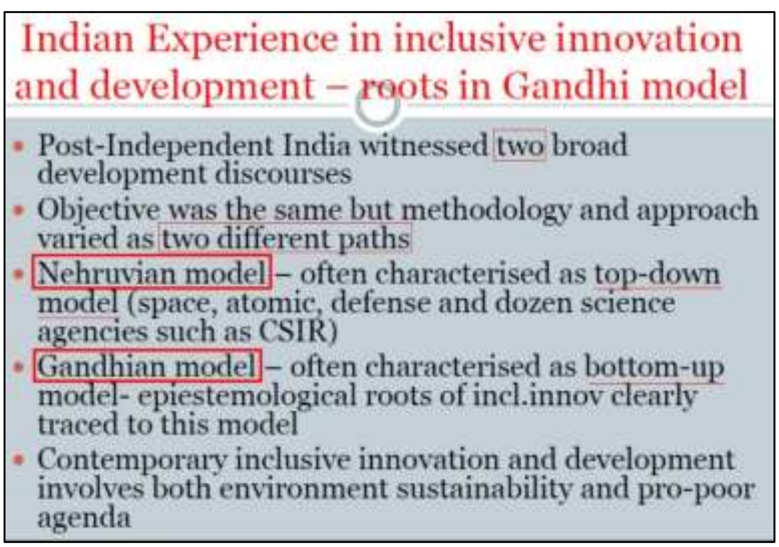


Fig. 20.3: OECD Advisory Group Meeting: Traditional Innovation Policy of India and Few Queries [231]

20.3. GDP Growth: Major Innovation Contribution should come from Corporate Sector to Develop Economy

The Broad objectives of different entities of the national innovation ecosystems are shown in following diagram.

Figure 20: Broad R&D objectives of different entities

MNCs	Academia	Corporate R&D	NGOs	National Labs	Start - ups
• R&D directed towards global business • Products customized for different regions based on economic, social, political and environmental needs	• Focus on fundamental research and capability development for staff and students • Emphasis on publications • Limited industrial research	• Product oriented research • More market focus • Aims at attaining high return on investment in products with respect to sales and profits	• Work focused on societal needs • Not normally profit oriented • Preference given to work related to rural development, optimized utilization of resources etc.	• Preference given to development of indigenous technologies beneficial for the nation. • Research projects selected by staff • Generate trained scientists for the country	• Focus on one particular field • Address smaller sized markets • Limited funds for in-depth research

Fig. 20.4: Broad objectives of different entities of national innovation ecosystem [149]

Like South Korea, Japan and Taiwan, the Corporate Research and Innovation can boost the GDP growth and national economy. It's a major factor for GDP Growth and most essential for becoming developed nation. Indian Industries are unable to focus on R&D and Innovation activities. The Government industrial R&D spending is less than 1% of GDP, which is not sufficient and Industry R&D spending is also not encouraging. To boost the innovation and in turn the GDP Growth the Industrial R&D centers should be built like South Korea.

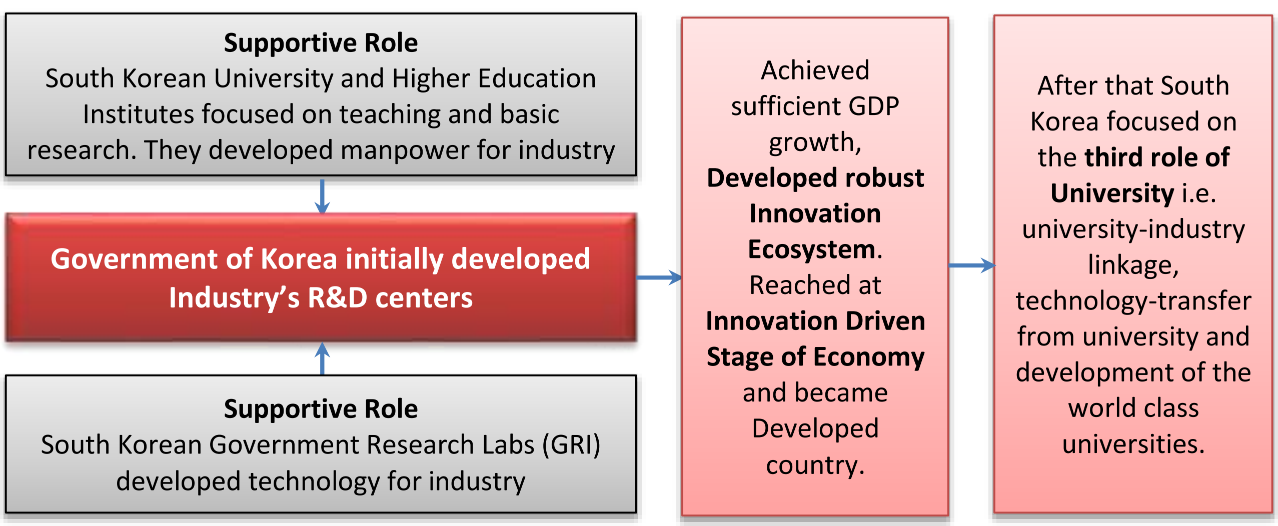


Fig. 20.5: South Korea's basic strategy for Industrial Research, Innovation & higher education

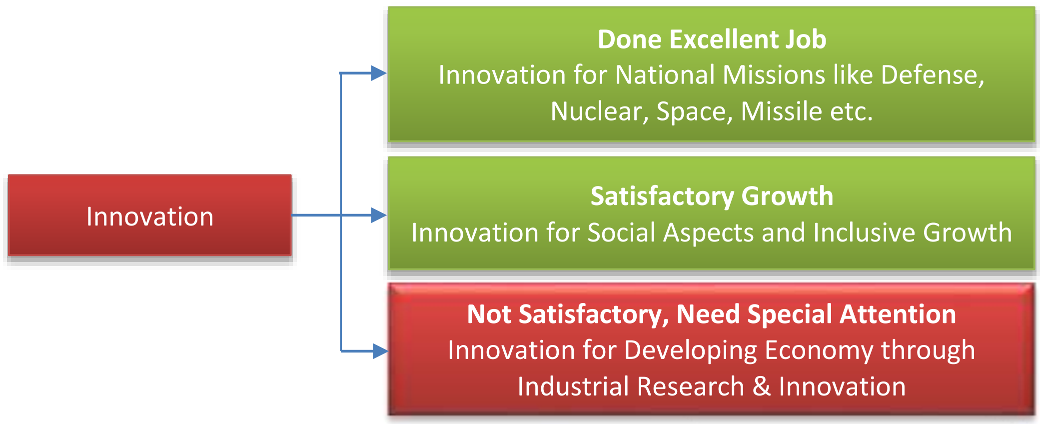


Fig. 20.6: To become developed economy the focus needs to be on Corporate or Industrial Research & Innovation

20.4. "Missing Driving Forces" to Boost Indian Innovation Ecosystem

In USA and Israel, the defense is the driving force for innovation ecosystem whereas in South Korea, Japan and Taiwan the Industrial R&D is the driving force. What is the driving force for Innovation Ecosystem in India? Let's try to find answer.

20.4.1. Defense: Not Driving Force like USA

Our Defense, Space and Nuclear R&D is limited to National Defense Laboratories. They have not encouraged and involved the Universities and Industrial R&D sectors like USA, China and Israel. Thus Defense is not the driving force for Innovation Ecosystem in India.

20.4.2. Industrial R&D: Not Driving Force like South Korea, Japan, Taiwan

Like South Korea, Japan and Taiwan, we have not focused on Industrial R&D to develop the national economy. Thus Industrial R&D is not the driving force for Innovation Ecosystem in India.

20.4.3. MNCs R&D Centers: Partial Driving Force but Not like Singapore

Like Singapore MNC can be an initial driving force for India and we are already moving in that direction. But remember that the MNC R&D centers are nothing but Virtual Brain Drain. There is a need of critical analysis of these R&D centers and policy to utilize this power for growth of our economy. But we can't adopt the strategies like Singapore. As on today, MNCs are a partial driving force for Indian Innovation Ecosystem. The Venture Capital Fund and FDI need special attention. It is one of the vital components for Innovation Ecosystem.

20.4.4. IPR Regime: Unable to Develop and Couldn't Become Driving Force

The Role of IPR in Creating Innovation can't be denied. The IPR Culture in India is in its initial stage. The IPR needs special attention. We must develop the IPR Policy to drive innovation, which should keep the balance between inclusive growth and industrial growth. The Indian IPR Policy should become role model for rest of the world.

20.4.5. University & Higher Education System: Supportive System Can't Become Driving Force

Innovation happen at the source of production or creation. Universities can play only a supportive role. The Universities in America or Israel are exceptions because of defense related activities. On top of this, in India, there are many restrictions from regulatory sector like "Not for Profit Clause", Taxation Policies etc., which is a main hurdle for developing innovation culture at University. We must use the IPR policy to boost Innovation contribution from university sector. In addition to this we need to focus on enhancing "Innovation Competencies" of students to develop better innovative brains.

20.4.6. National Laboratories: Couldn't Act as a Driving Force

Role of University and National Laboratories should be supportive to Industrial and Defense R&D. The National Laboratories should play a proper role for developing Innovation Ecosystem. Unfortunately in India the industrial R&D is not on driving seat. That position is occupied by national laboratories. The Indian National Laboratories couldn't involve the Universities and Industries in national mission. They could not emerge as a national leader or driving force for Innovation.

20.4.7. Inclusive Innovation Policy: Couldn't Act as Driving Force

The National Growth should be Inclusive and it is must for large country like India. The growth should be balanced and must follow the principle of equity and excellence. **But the Innovation can grow in Innovation Clusters along with healthy Innovation Ecosystem. It can't grow in isolation.** Unfortunately it is difficult to develop the Innovation Ecosystem with considerations like

- Inclusive growth
- Balanced growth
- Access
- Equity consideration etc.

Like Silicon Valley, the concentration of resources at one place can boost Innovation, which normally creates skewed growth. The Indian Innovation Ecosystem is giving importance to National Laboratories and Inclusive growth but unable to focus on Industrial Research & Innovation.

20.4.8. Frugal Innovation: Major Strength but Unable to Convert into Driving Force

The Frugal Innovation is the strength of India. But unfortunately we couldn't develop mechanism to convert the "Jugaad" in to Frugal Innovation and patent culture. The Frugal Innovation along with considerations for safety, environmental impact, aesthetics and sustainability are needed.

20.4.9. Leaders: Very Few Leaders of the Organizations could become Driving Force

There are very few leaders, who could become driving force to drive innovation like

- Industry: Ratan Tata (Tata Group), Dr. Devi Shetty (Narayana Hrudayalaya), Dr. G. Venkataswamy (Aravind Eye Clinics) etc.
- Academics: VC of Punjab University and Delhi University

Unfortunately, the government of India could not focus on this issue. The "search committees" of Vice Chancellor or Director of National Laboratories become "selection committees". They invite application for the post and select the candidates and never try to conduct the independent search for better leader for the organization. There are many legal issues. I have discussed almost every issue on this subject in my book "113 Difficulties in Developing World Class Universities".

The innovation culture is not yet spread in the Indian industries. The innovation leaders are available but unable to get chance to become driving force.

20.5. Need to Learn from South Korea, Japan and Taiwan

India needs to learn from the South Korean R&D strategy. The South Korea has developed industrial R&D centers for sustaining and enhancing the GDP growth rate and developed robust Innovative Ecosystem. After that they have focused on higher education development, university-industry linkage, technology-transfer from university and world class universities.

Once the industrial R&D wing is developed, for cost effective research solutions, they may come forward and join hands with the Universities and Higher Education Institutes.

Every nation needs Innovation at large scale and the major share comes from industrial R&D centers. The Universities / Institutes of Higher learning and Government R&D labs can play only supportive role. The nation shouldn't be over dependent on MNCs. It's "Virtual Brain Drain".

The important conclusions from the Case Study of South Korea are:

- High Rate of Innovation is required to become Developed nation
- Major source of innovations is Industrial R&D
- Universities, National Laboratories, MNC, Frugal Innovations can play only supportive role
- Main role of University is to provide employable, innovative and creative brains and develop research culture. The secondary role is innovation through technology transfer.

In addition to this the other measures are:

Fig. 20.7: Innovation Policy and Recommendations [425]

20.6. After "Skill India" and "Make in India", We Need "Innovation India"

Without "Political Will" nothing can happen in any democratic nation. The recent slogans "Skill India" and "Make in India" definitely bring the positive change. I feel that one more slogan is badly needed to become developed nation, which is nothing but **Innovation India**.

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