



**Dr. P K Dan**

**[Part – 1]**



# The context and Priorities: influencing Opportunity and Scope



- If we plan to do anything – where do we do it?

Where lies the Scope?

Or, more precisely who do we target; and what is that market?

- Where should we focus for Innovation or Entrepreneurial efforts?  
and also very importantly as to, How?

- First, about the emerging market opportunity:

**5.5 Billion people live in low-income countries or emerging economies in a world with a population of 8 Billion (1.4 bn in India alone).**

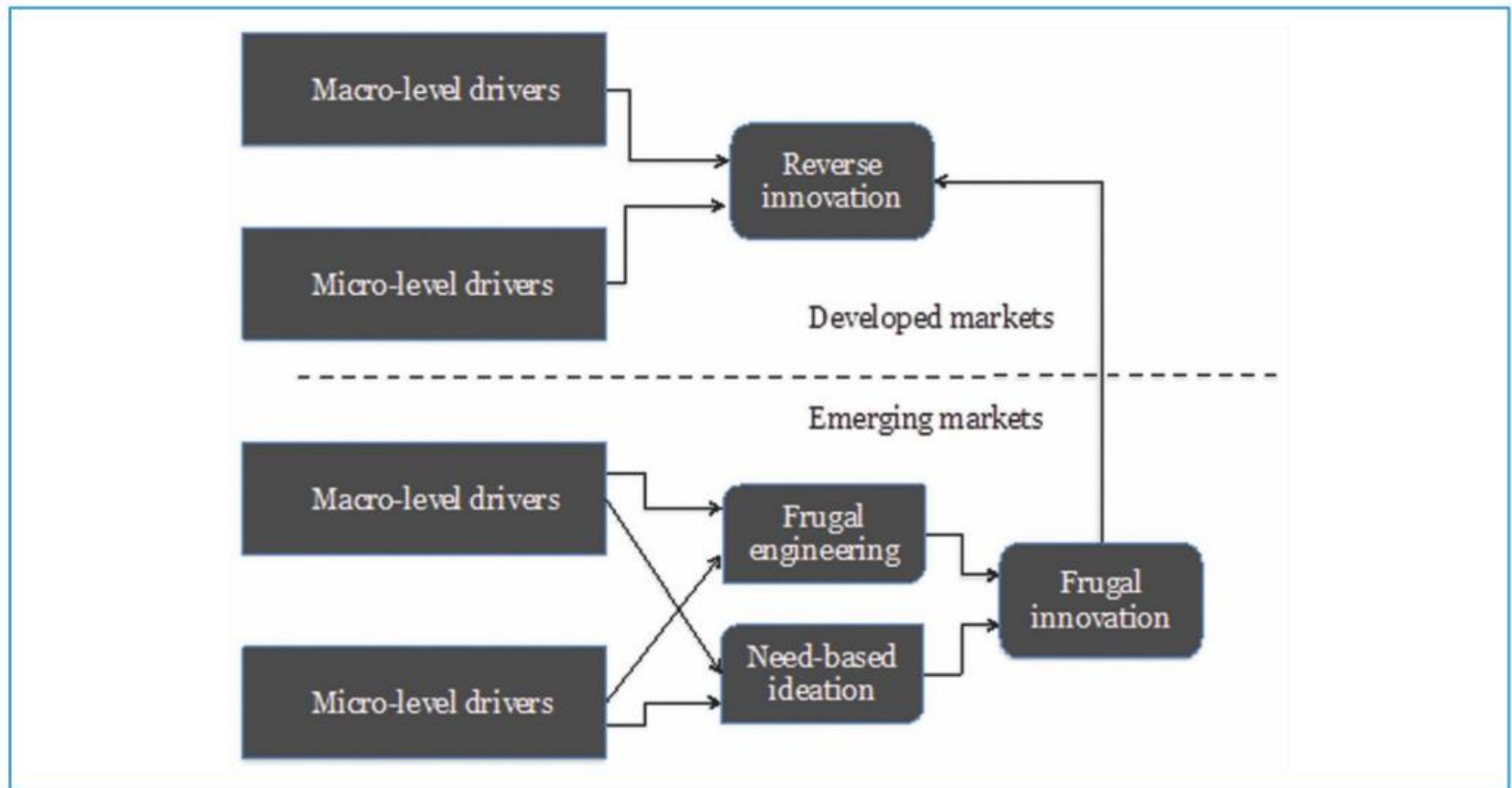
This **market**, for **innovative products** or service **designed** with **frugal** or affordability **engineering**, is actually larger if we consider an immense opportunity through ‘Reverse Innovation’ process.

(‘Reverse Innovation’ will be discussed along with Frugal Engineering)

# Reverse Innovation (RI) vs. Frugal Innovation (FI)

Source: Simula et al. (2015)

**Need-based solutions and frugal engineering - two principal sources of frugal innovation** and the fundamental building blocks in conceptual framework relating FI and RI. (Sometimes FI becomes RI)



## INNOVATION AND LEADERSHIP (Vision and Resilience) IS THE COMMON ELEMENT : SO WILL BE THE FOCUS and THE JOURNEY





# Industry and Innovation

- “There is no other organizational capability with such a gap between importance and performance. In the 2015 BCG survey, 70% of executives replied that innovation was either the company’s top priority or among the top three.
- Other surveys by IESE, KPMG and The Conference Board confirm these numbers.
- Executives consider innovation as the most critical capability for the future success of their companies. But when asked about their satisfaction with the performance of innovation, less than 20% of the executives was happy based on a survey of our clients.”

—London School of Economics and Political Science, 2016

**Firms are accelerating efforts to change their cultures, foster innovation, and serve customers more effectively.**

## Report on Innovation Strategy for Frugal Products

■ Over the past few years several media and Consultants' report indicate that the emerging markets are becoming dominant determinants in global business and is illustrated with following examples:

■ **ToI** reported some years ago, under a heading '**Reverse innovation: More MNCs take India's frugal engineering global**'

where one of the examples was of **Samsung**, a South Korean Global Company which is taking advantage of **frugal engineering** and lower development costs in India for developing products which are cost-effective and relevant for global market.

The other example was of **Renault**, the French car manufacturer, that developed a car conceived and build from scratch by its Indian R&D, as a part of **Frugal Engineering Strategy** championed by **Carlos Ghosn**, the CEO of Renault-Nissan Alliance.

**LG, BSH (Bosch and Siemens)** also undertook similar developments.

# Report on Value sensitive (Cost & Quality) Emerging Market

- According to the Consulting firm, **PWC**, the **Global Emerging Middle (GEM)** is a class of consumers define a critical growth horizon for companies over the coming decade. Termed as the '**Next 4 Billion**' in countries like India, China, Indonesia, Africa and Latin America where over 4 billion people lived, only few years back when world population was 7 billion. If the **next lowest bracket is considered, it will cross 5 bn. A market of USD 6 Trillion, annually**
- Enterprises are challenged, in this market, to come up with **new value propositions** with new ways of thinking (**Quality and Affordability; Quality is fulcrum**). Innovations / products developed in these countries can be exported to Western countries (Reverse Innovation).
- Companies, according to the consultants, have to **collaborate with key players in the emerging economy** to supports their business model. While **prototyping and pilots are required in the initial stages, scale solutions are essential for success.**

## Key Pointers from Reports for Planning Design and Innovation

- New Value Propositions
- Products with Quality and Affordability; Quality is fulcrum
- Frugal Innovation and Reverse Innovation
- Affordability Engineering or Frugal Engineering
- Defining Innovation for Identifying and Executing Projects
- Application of Technology in economic manner
- Gain economic leverage by serving large population and market

The **above, focused on product**, to be addressed through:

**Frugal Design (FD) Thinking**

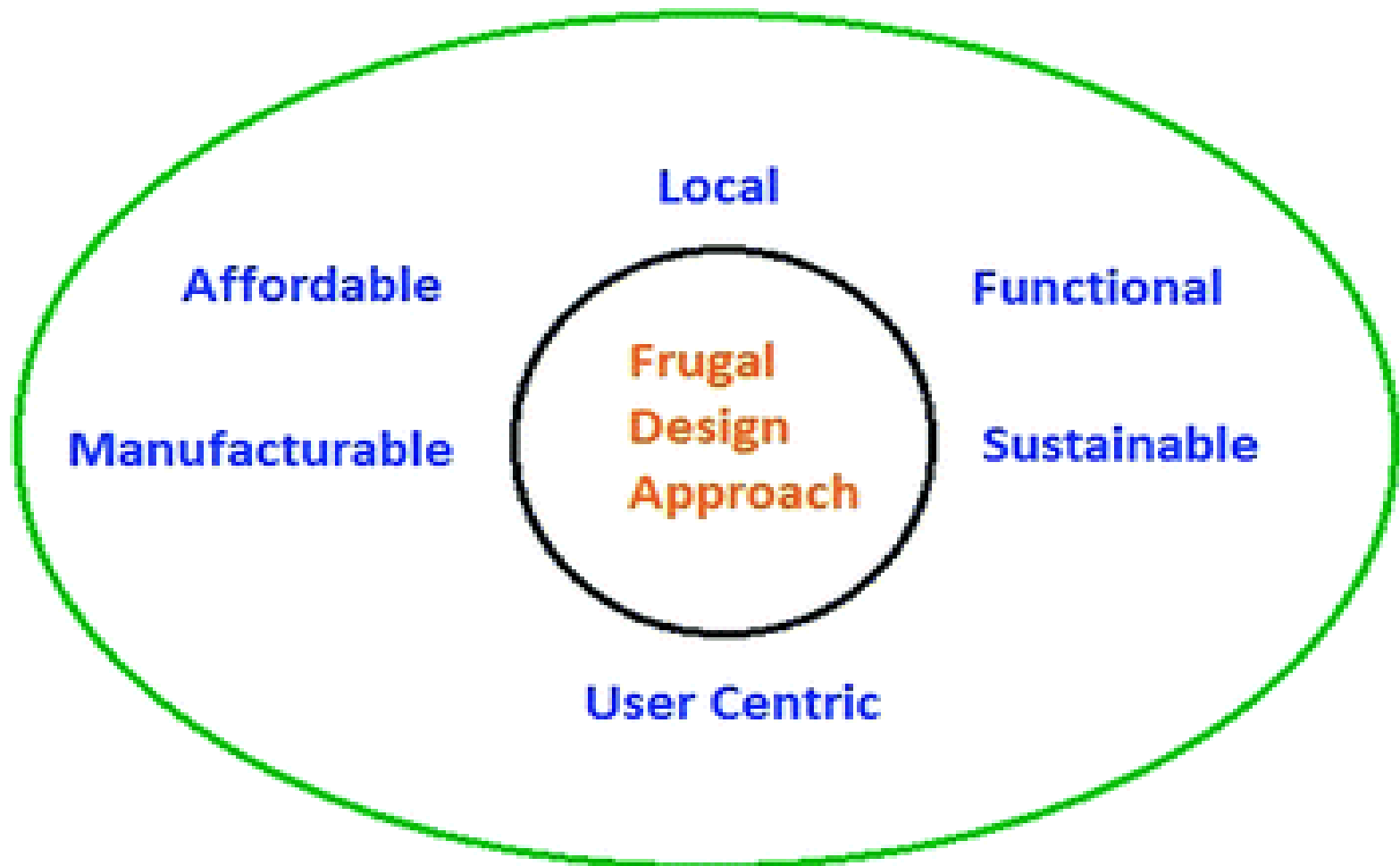
**Engineering Design and Innovation**



# Frugal Design Thinking:

## Features integral to frugal design approach

[https://link.springer.com/chapter/10.1007/978-981-10-0606-7\\_4](https://link.springer.com/chapter/10.1007/978-981-10-0606-7_4)



- **A definition of Innovation:** Executing an **idea** which **addresses a specific (real) challenge** and **achieves value** for both the **company** and **customer** (*summarised by N. Skillicorn*)
  
- **A definition of Frugal innovation in market:** New or significantly **improved products** (both goods and services), **processes, or marketing and organizational methods** that seek to **minimize the use of material and financial resources in the complete value chain** (development, manufacturing, distribution, consumption, and disposal) with the objective of significantly **reducing the total cost of ownership and/or usage while fulfilling or even exceeding** certain pre-defined criteria of **acceptable quality standards** (R. Tiwari and C. Herstatt).

# Frugal Engineering is Ubiquitous



- Frugal Engineering practice and Frugal Innovation approach spreads across High Technology domain to conventional technology domain.

It is applied in developing Space Craft (MoM) as well as for small Refrigerator (Godrej, Chotukool), which is electrical battery operated where electricity is not regularly available.

For designing Car (Nano, Kwid or Logan) to designing incubator for infants (Stanford)

For designing Electrocardiogram Machine to Ultrasonic Scanner (GE)

For X-Ray machine (Siemens) to Prosthetic Limb (Jaipur Foot)

Therefore it can be employed for and at any technology point in the entire engineering design space.

It combines technologies like artificial intelligence or IoT, together with standard and existing ones to create Frugal Products.

# Frugal Engineering: Meaning and Principles



- The term '*Frugal Engineering*' was first coined in 2006 by Carlos Ghosn, the CEO of Renault, who ascribes it as the process of designing and developing the world's cheapest car targeting the base of the economic pyramid customers in India - **TATA Nano**.

Large western companies began to use Tata Motors' strategy (Andrea Bencsik et al., 2016)

- Frugal engineering concept is rooted in, Appropriate Technology, the frugal innovation philosophy and epitomises the actual process of developing frugal products.
- Therefore, **Frugal Innovation is a philosophy**, while **Frugal Engineering refers to the actual product development practices** and the **result of frugal engineering are frugal products** (for BoP Market including RI).
- **Frugal engineering** is an approach to product development which scrutinizes the wastefulness of over-engineered products, and challenges the traditional business model for R&D of Western companies.

## Frugal Engineering: Meaning and Principles (Contd.)

- Frugal engineering consists of a set of principles and methods used to design and develop low-cost, high-quality products in order to satisfy the needs of Base of the Pyramid (BOP) markets.
- Though cost cutting is a salient feature of frugal engineering, the consideration, rather, is for avoiding unnecessary costs while to ensure that the product is functional in resource constrained environments.



- Non-traditional Supply Chain is an important need.

We will see some examples

# Innovative Frugally Engineered products: Examples

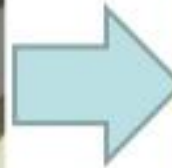
Such as, Medical Equipment, Agricultural Tractors, Automotives, Refrigerators etc with drastic cost reduction while preserving value

**MAC 400 ECG Machine:** General Electric, for instance, has developed several healthcare devices for rural markets in emerging economies and **electrocardiogram** is one such device. Normal cardiograms are very complex devices and only trained cardiologists are able to use them, while General Electric's frugal cardiogram removed all unnecessary components and reduced product and process complexity significantly by using substitute locally available materials, use **printers from local bus terminals** and off-the-self components.





# \$10K vs \$1000



## Electrocardiograph MAC400

healthcare

The GE MAC 400 in use in a remote village in Karnataka, India

A photograph showing a doctor in a white coat and stethoscope using the GE MAC400 machine in a remote village. The machine is placed on the floor, and the doctor is sitting next to it, attending to a patient lying down. A woman is also present, holding a child. The setting is a simple room with a pink wall.

**making ecg available  
to every physician,  
every patient, everywhere!**

## Tractor for Agri-farming developed with Affordability (Frugal) Engineering

- Small range Diesel engine operated tractor, 'KrishiShakti' enabling farm mechanization in an affordable manner has been developed by CSIR – CMERI (Central Mechanical Engineering Research Institute). This low-cost, compact and easily manoeuvrable tractor, perfect for small size lands, is for farming and transportation.



**TATA Nano:** One of the most referred frugal engineering outcomes is the world's cheapest car

The aim of the design features presented is to lessen complexity of procurement and production processes and considerably lowering of costs.





# Siemens Multix Select DR (X-Ray Machine)

- At nearly one third the price of the products within portfolio
- Due to rising cost pressures and a competition, healthcare providers want a budget-friendly solution for good-quality general radiography. It is a floor-mounted digital X-ray machine that combines facilities and features namely, cost-effective room setup with a high level of clinical flexibility.
- Outstanding image quality is achieved by selecting from best technologies. It provides greater financial flexibility with a digital X-ray machine that offers expert solutions for general radiography in an economical way.



## Fetal Heart Monitor and Frugal SMART products from Siemens

- **Siemens**, the Germany based industrial conglomerate through its **R&D centres in emerging economies (India and China)**, developing frugal solutions for delivering better value to consumers. **Siemens' engineers at Indian centre, in collaboration with their German counterpart** have developed a **Fetal Heart Monitor**, designed with **inexpensive microphone technology** instead of using **ultrasound technology**, which is pricy.



## US \$200 billion global market for **SMART** portfolio

- This Fetal Heart Monitor, affordably engineered, is part of **Siemens'** expanded portfolio of frugal solutions, classified as '**SMART**' (**Simple, Maintenance-friendly, Affordable, Reliable, and Timely-to-market**). **SMART** products are about **50 percent cheaper** than conventional high-end solutions.
- Those are also easier to implement besides being energy-efficient and its popularity can be guessed from the company's estimate of a **US\$200 billion global market for SMART portfolio**.



- According to Peter Löscher, CEO of Siemens, “Scarcity of resources is not an impediment but an enabler (of innovation).” as reported by N. Radjou.



## Jaipur Leg/ Jaipur Foot

- A low cost prosthetic ‘Jaipur leg’ developed in India, costs only about \$150 to produce, that embodies improvisations by adapting irrigation piping into the design to reduce cost.



**Dr. PK Sethi and Master Ram Chandra Sharma**  
Inventors of the Jaipur Foot



# Infant Warmer/ Incubator designed at Stanford University

- **‘Embrace’**, designed at Stanford University in the US, where a team of graduate students ideated for creating an **inexpensive infant warmer**, used as **incubator**, that functions as a low-tech device.
- Embrace has the potential to **save thousands of babies** in the **developing world**.



# A Chinese Example: X-ray machine, Zhongxing Medical

- Principle adopted: BORROW and REUSE
- Innovation: By Re-engineering an underused technology (in an aerospace company in Beijing) to build equipment costing only \$20 K compared to \$150K models of GE and Philips.
- To achieve this, a trade-off was made. Rather than engineer the equipment for wide range of sophisticated scans (common in Western hospitals), it focused on a device to perform only the chest scans, the vast majority among scans. Understanding the primary needs of its target hospitals, those cannot afford a conventionally priced X-ray m/c, the product was built.
- The company developed a digital direct X-ray (DDX) equipment-product based on 'line-scanning' technology acquired from its parent company (Beijing Aerospace) via a Russian partner, that was regarded obsolete by GE and Philips, the then market leaders in this area. This captured 50% of China's X-ray market, compelling GE to cut prices by half and Philips to exit.
- Chinese companies, in general, have applied cost innovation into three areas: (1) high technology at low prices; (2) product variety at mass-market prices; and (3) specialty products at low prices.



India is where Prof. Amos Winter of MIT developed an all-terrain wheelchair, and it's the country that acts as a real-world laboratory for him. Here, the consumer earnings are less, has a different culture, and hence he tries to capture those factors and combine it with the engineering theory to create low-cost, high-impact technologies at the Global Engineering Research Lab (GEAR) of MIT.

(<https://www.fastcompany.com>)





## Some more examples.....to understand Unique Value Proposition

- **ChotuKool fridge:** A tiny refrigerator ‘ChotuKool’, sold by Godrej Ltd.(India) the may have more in common with cooling system used for computers unlike other refrigerators; it removes the traditional compressor for a computer fan.

- **Foldscope:** Designed at **Stanford University** to cost no more than a **US dollar**, the Foldscope is a non-fragile **origami microscope** assembled from a **sheet of paper and a lens**.



- **Nokia 1100:** Designed for developing countries, using basic features besides being durable. More than 200 million units got sold in only four years after its introduction in 2003 as one of the best selling phones of all times.



- **Aakash Internet Tablet:** Developed by a technology company ‘Datawind’ for Indian government to provide low-cost tablets to students in India.

**ISRO's Frugal MoM;** Low-cost (80 Million USD) Spacecraft, Mangalayaan, for Mars Orbiter Mission (MoM) with an outlay of only 10 %, compared to MAVEN, built by NASA. It is based on Frugal Engineering, as it adopted available technology as much as possible. The concept was that instead of directly flying to Mars, the vehicle would orbit the earth for about a month, building up velocity to slingshot its way out of earth's gravitation to embark on its 400 million kilometre journey. The quality and reliability has not been compromised - the Mangalyaan mission, which was initially meant to last six months, has completed five years of orbiting Mars and is likely to continue for some more time.....

