

**HISTORY OF
SCIENCE AND TECHNOLOGY
AND ITS FUTURE
WITH FOCUS ON INDIA**

PRE-HISTORY

1) SCIENCE

- A Body of Knowledge

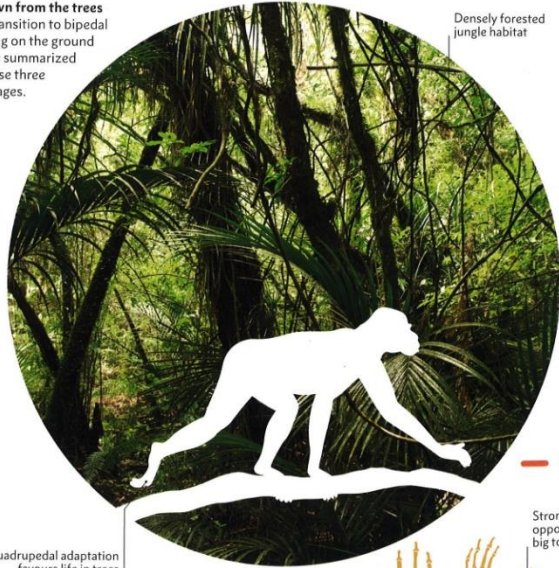
2) TECHNOLOGY

- A Body of Skills, Tools and Techniques

Advances in knowledge, skills and tools has been a part of human evolution – much before the Art of writing was discovered.

EVOLUTION OF HOMO ERECTUS TO HOMO SAPIENS

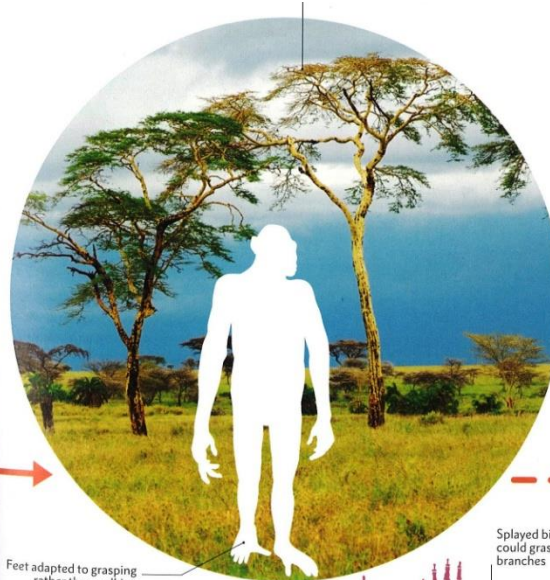
Transition from the trees
Transition to bipedal
Walking on the ground
Summarized
in three
stages.



Densely forested
jungle habitat

Quadrupedal adaptation
favours life in trees

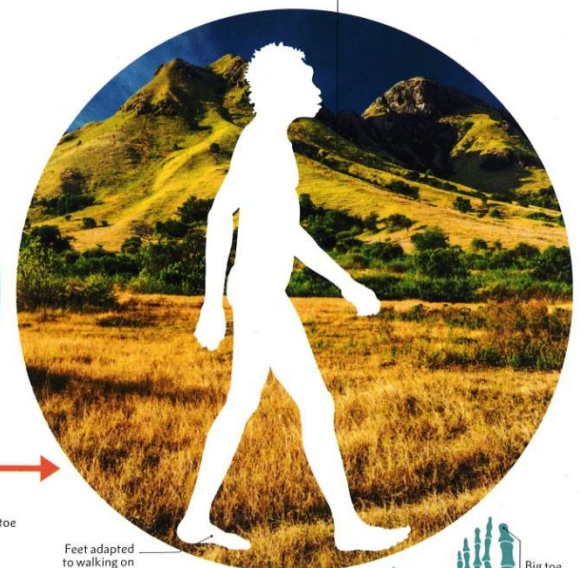
Strong,
opposable
big toe



Feet adapted to grasping
rather than walking



Splayed big toe
could grasp
branches



Feet adapted
to walking on
open ground



Big toe
aligned

- Liberated hands from the drudgery of movement - free hands interacting with growing brains along with other senses, especially eye sight took us far ahead of our ancestors.
- Our ancestors started moving around.
- Throwing stones, saw spark
- Fire was discovered.
- Socialization and group dynamics developed.

MESOLITHIC AGE

- 1) Domestication of Dog – Other small ruminants like Sheep and Goat
- 2) Microlith

MESOLITHIC TIMES

MESOLITHIC HUNTERS AND FOOD-GATHERERS

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Fig. 35. A mesolithic scene. A man is shooting an arrow tipped with a sharp microlith at an antelope. The other is throwing on a deer a spear tipped with a sharpened stone (Reconstruction from the Museum of Evolution of Life, Chandigarh)

NEOLITHIC AGE

- 1) Domestication of big animals, cow, buffalo, horse, ploughing, Irrigation
- 2) Wheel moved in – Pottery, Basketry, Housing & Loom
- 3) Nomads started settling

NEOLITHIC TIMES



Fig. 48. A Neolithic rural scene, depicting the harvesting of wheat and barley with stone sickles, with clusters of huts in the background
(Reconstruction from the Museum of Evolution of Life, Chandigarh)

ANCIENT TIMES

1) GROWTH OF POPULATION

2) CONCEPT OF COUNTRY

3) CONCEPT OF STATE

STATUS OF SCIENCE, TECHNOLOGY AND MATHEMATICS

(FROM 2000 BCE TO 1200 CE)

- 1) Temple architecture bloomed across India. Thanjavur, Madurai, Kailashnath at Ajanta and Ellora, Dilwara and Vimlavashi in Rajasthan, Nalanda, Vikramshila and Khajuraho are living examples of the glory of those days.
- 2) Medicine, surgery, astronomy and mathematics was well developed. Aryabhatta, Varahimihira, Brahmagupta and Shushruta are well known names.
- 3) The concepts of pi, zero, decimal numerals, square root, cube root and quadratic equations were known.

POPULATION (In Crores)

Year	0 CE	1000 CE	1200 CE
INDIA	7.5	7.5	8.9
WORLD	23.8	26.76	33.59

PER CAPITA INCOME (In Dollars at 1990 Rate)

India was at the apex of the Global Economic order.

Year	0 CE	1000 CE	1200 CE
INDIA	450	450	490
WORLD	445	436	488

MEDIEVAL TIMES

FROM 1200 CE TO 1750 CE

POLITY: It was predominantly an Islamic polity. Ghori, Khilji, Tughlaq, Saiads, Lodhi, Moghuls, Bahamanids, Qutubshahis, and Asaf Jahis are familiar names of various dynasties. They straddled across a major geography of the subcontinent. There was a Hindu Vijayanagara kingdom and Ahom rulers too.

TAXATION: It was the canonical **Al-Kharaj as per the Treaty of Khaybar**. All rulers, be it in Damascus, Baghdad, Kabul, Delhi and Deccan followed the same taxation rate.

50% of the gross produce was mandated to be taken from all farmers as Al-Kharaj by the state. Default was met with stringent measures. There were other duties too.

SCIENCE, TECHNOLOGY AND MATHEMATICS

All these disciplines suffered. Libraries were torched, printing press, ship fitted with cannon were revolutionizing Europe. The discoveries, however, did not reach India. Similarly, the scientific revolution of the seventeenth century remained confined to Europe.

LANGUAGE

- 1) Persian was the official language of all the courts in India. No book was translated in Persian. Printing presses were multiplying across Europe. None came to India. No books were available, even in Persian. So the scientific society could not take roots, either in India or in Ottoman Empire.
- 2) All Empires under Islamic rule such as Ottomans, Delhi Sultanate and Mughals, regressed in science, technology and mathematics.

POPULATION (In Crores)

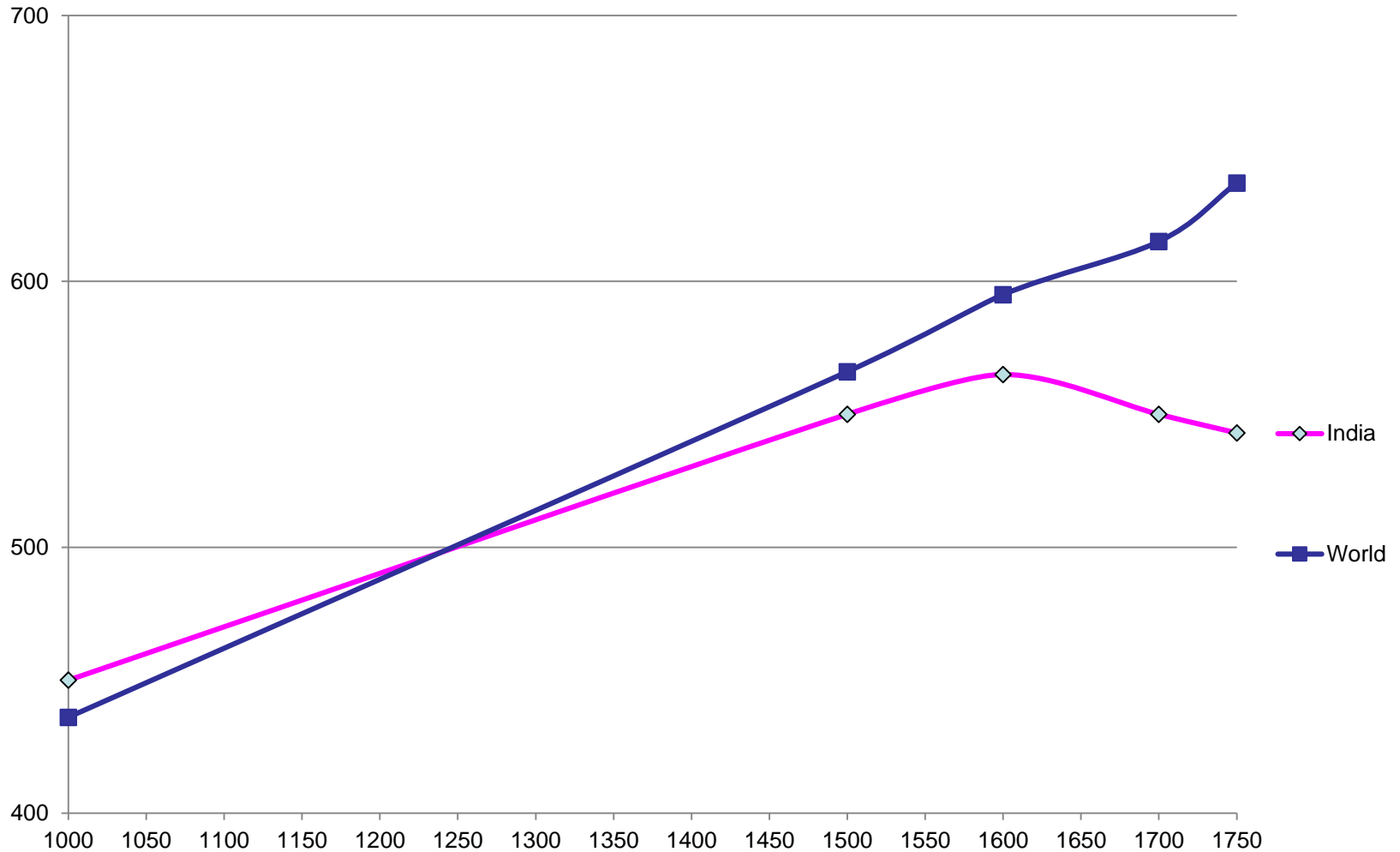
Year	1200 CE	1750 CE
INDIA	8.9	18.3
WORLD	33.59	78.6

PER CAPITA INCOME (In Dollars at 1990 Rate)

Year	1200 CE	1750 CE
INDIA	490	543
WORLD	488	637

PER CAPITA INCOME AT CONSTANT PRICES

(FROM 1000 CE TO 1750 CE)



BRITISH TIMES

SCIENCE, TECHNOLOGY AND MATHEMATICS

(FROM 1750 CE TO 1950 CE)

It was a bleak period for India. However, it was golden period in Western Europe. It witnessed a plethora of scientific discoveries and new mathematical disciplines. On technological front, it witnessed gunning, coal, steam power, locomotive, telegraph and a railway network.

The Economic drain:

- 1) Advanced technology made UK the dominant importer of cotton and export of finished cloth. The weavers in the sub-continent were destroyed. The bones of weavers are **bleaching the plains of India' (Metcalfe)**.
- 2) Steel factory and cotton factories came as late as in 1890 and 1907 CE. By that time, the Indian Economy was substantially drained out. While, **UK Boomed, India was Doomed**.
- 3) If economy dries up, the society cannot remain strong. It lost its vitality, Caste discrimination, religious conflicts and women's subjugation were the manifest social outcomes.
- 4) In a latest research paper, Mrs.Patnaik has calculated **"Theft of \$45 trillion by EIC & British empire from India between 1765 & 1938"**. It is seventeen times more than the total annual GDP of the United Kingdom today.

POPULATION (In Crores)

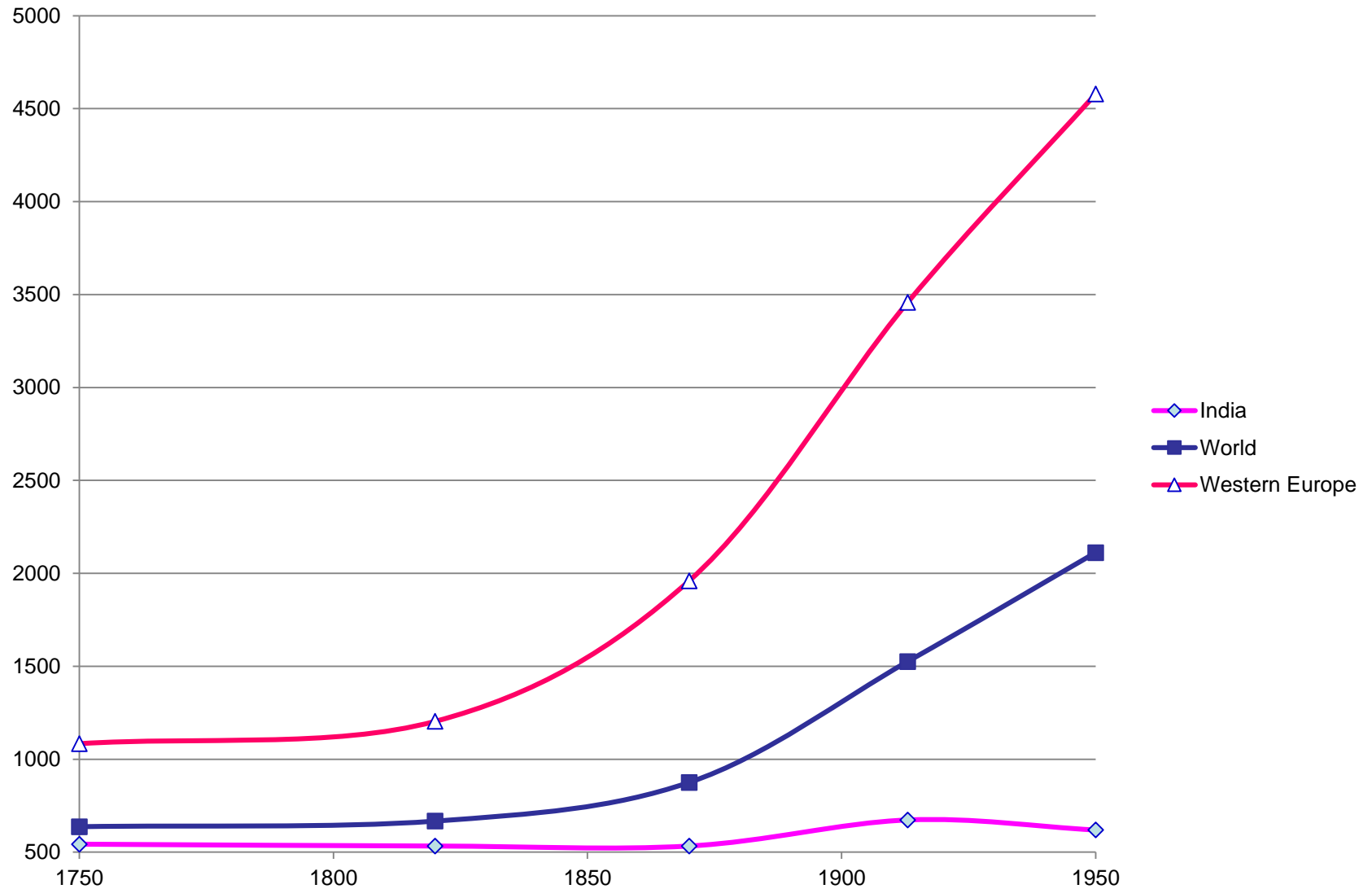
Year	1750 CE	1950 CE
INDIA	18.3	35.9
WORLD	78.6	252.4

PER CAPITA INCOME (In Dollars at 1990 Rate)

Year	1750 CE	1950 CE
INDIA	543	619
WORLD	637	2111
WESTERN EUROPE (Including U.K.)	1084	4579

PER CAPITA INCOME AT CONSTANT PRICES

(FROM 1750 CE TO 1950 CE)



SEVENTY FIVE YEARS

AFTER INDEPENDENCE

INDIAN SCENARIO IN 1950

- 1) It was technologically desiccated and economically impoverished
- 2) Literacy was around 16%
- 3) Irrigated area was around 18%
- 4) Life expectancy was 32 years
- 5) Productivity of crops, milk and meat was the lowest in the world

AGRICULTURAL TECHNOLOGIES

1) Green Revolution

- a) Magic of irrigation
- b) Cross bred seeds
- c) Fertilizers
- d) Drought resistant varieties

All this has taken food production from 50 MT – 300+ MT

2) Same pattern has made it possible for White Revolution

From 20 ML to 180 ML

NUCLEAR ENERGY

- 1) New Institutions like BARC and DAE were set up
- 2) Nuclear Fission – Atom Bomb –
Hydrogen Bomb

ELECTRONICS

Shockley Effect – Transistor

- Tubes to Chips to Super chips
- Radio & TV
 - Large size computers – Desktop computers
 - Laptop computers – Palm top system
- New Public Sector Units like BEL, ITI and new institutions like IITs were established

COMPUTERS

- 1) Government policy encouraged production of Hardware and Software in private sector
- 2) Computers – Pattern recognition
 - It can learn languages
 - Mayan Civilization – Decoded
 - Saraswati Indus Valley Civilization – Work in progress

DNA - LINUS PAULING

- 1) It is a three dimensional helical structure
Human Genome project is completed
Genetic Engineering – Stem cells
- 2) In Archeology, Skeletal remains have been tested. Our understanding of history is getting updated.

PHOTONICS

- 1) Photo Voltaic cells
- 2) Solar Energy
- 3) Costs have come down – Commercial production has become quite viable
- 4) International solar alliance

COMMUNICATION THROUGH LIGHT

- 1) Optical Fibre Cables (OFC)
- 2) The villages are connected through sufficient Bandwidth all across the country

SPACE TECHNOLOGY

- 1) Space Travel – Needed new materials & Solid fuels – Space Journey has become possible
- 2) Satellite launch - Indian has come a long way

LASER

- 1) Bullets, Rockets, bombs
- 2) BALAKOT has become possible

PLATE TECTONICS

Better Predictability of
Earthquakes and Tsunamis etc.

SOCIAL IMPACT IN INDIA

- 1) Media, especially Radio has played an important role in Green Revolution
- 2) Social media – People can see and be seen
- 3) Digitization – So many families are getting various state benefits - directly
- 4) OFC and Photonics would make information and energy very cheap and affordable to all

NEXT TWENTY FIVE YEARS -

AMRIT KAAL

A.I. TECHNOLOGIES

Algorithm can be defined as step by step, streamlined, repetitive and predictable procedure.

In 1979, an average computer program could beat an average player of Chess.

In 1997, an IBM computer program named Deep Blue defeated Garry Kasparov, the reigning world chess champion.

The question is, who is a better player? Any human being on planet or a routine program called 'Deep Blue'.

A.I. ECOSYSTEMS

A.I. has to be understood beyond its technological dimension.

It includes the entire ecosystem, which includes quantum computing, semi-conductors, 3D printing, robotics, aerospace, 5G and much more.

A.I. as an umbrella term leverages their development, synergises them and propels forward as their force multiplier.

A.I. is amplifying human ingenuity and driving latest technological disruptions.

It is silently yet irrevocably shaking the existing economic and social foundations.

A.I. TECHNOLOGIES

Two fundamental concepts of A.I. are Machine learning and Big data.

Machines are getting better, better informed and more intelligent.

Due to constant learnings and adaptation, they easily are mimicking human faculties.

Speech today, Thoughts tomorrow, Emotions Day after?

WHAT A.I. HAS ALREADY DONE

A.I. has already impacted medical diagnostics and treatment. Agricultural science and technology; education, entertainment, transportation, safety, strategic weapons, financial management, legal and judicial processes etc.

As Algorithms became more sophisticated, common tasks are likely to be done by A.I. enabled systems. Guided drones, driver less cars. Such jobs are likely to become populated by these new gadgets. What happens to those who are employed there as on today.

Are we at the tipping point of history? In Agricultural revolution tribals lost out. In Industrial Revolution, farmers lost out. In Service sector Revolution, Blue collar workers lost out. In A.I. Revolution, are white collar jobs going to face a challenge from new E-Collar workers.

A.I. AND JOBS

A.I. propels economy; It also collides with job market. It creates new jobs; but simultaneously renders, several existing jobs redundant.

World robotics are growing at the rate of 15% per annum since 2008. Some estimates show that by 2033, probability of computers replacing 90% accountants, 89% of taxi drivers, 43% of economists, lawyers and chartered accountants may be expected.

According to World Bank President's assessment, 69% jobs in India and 77% jobs in China's job market are under threat due to automation.

BATTLE FOR JOBS

A.I. would be a force multiplier; gap shall go up. New Haves & Have nots would emerge. A belief that philanthropy from the elite company would bridge the gap is rather utopian. It would grab headlines, not really solve the challenge. State has to understand and prepare for the emerging onslaught. Economic restructures precipitated by A.I. impact could lead to prolonged social unrest in various sectors – farmers, small business, youth, bankers etc.

It may evolve into a catastrophic result.

SOCIAL IMPACT

Only a fraction of total population would be involved in propelling this new wave. Others would function as platform workers due to increasing uberisation.

Incidence of inequality is likely to increase or remain stubbornly high. Gini coefficient is likely to increase by 2 points.

The historical equilibrium between capital and labour is already under stress. It is likely to accentuate with A.I. interventions.

GLOBAL IMPACT

Countries like USA, Germany, Japan, Korea, China and to some extent, India are likely to be the leaders in the race. Within India, already I.T. savvy states like Delhi, Pune, Hyderabad and Bangalore are likely to be in the lead. Within these states too, only a fraction of population would be propelling this new wave. Others would be employed indirectly in uberisation like jobs.

Are we moving towards data capitalism?

GLOBAL POWER SHIFT

Is USA today and China tomorrow,
the new power lords on this planet?

Where is India in this evolving global
dynamic?

THE NEW CAPITALISTS

In the beginning of 20th century, Henry Ford, the car maker was the richest man of the world. By the beginning of 21st century, Bill Gates, the computer software provider was the richest man.

During the last 2 decades, new capitalists like Google, followed by Facebook, Amazon and Microsoft have emerged on the global horizon. They have amassed humungous data, about human beings; about you and me. They are using it to change our behaviour.

Can we call them Surveillance capitalists? The new haves numbering less than 7 in a world inhabiting more than 7 billion humans.

THE EMERGING DEITIES

Are Google, YouTube, Face Book,
Amazon & Twitter, the new Deities.

Or is it Tesla? Or someone else, yet
to emerge which we don't know!

THANK YOU