

## UNIT - 01

### Elements of Industry (I.O)

#### 1) **Different Revolutions**

First industrial revolution → invention of steam machines.

↳ usage of water

↳ steam power

↳ lead to industrial transformation of society  
(manufacture, labour, government, etc.)

↳ mechanisation

→ 1760 - 1840

↳ triggered by construction of railroads & the invention  
of steam engines at start of 18<sup>th</sup> century  
↳ ushered mechanical production

#### 2) Second Industrial Revolution →

→ period of electricity introduction to industry

→ new manufacturing 'inventions'

→ mass production enabled.

(some extent of automation)

→ late 19<sup>th</sup> century - early 20<sup>th</sup> century

[electricity, e.g. assembly-line]

#### 3) **3<sup>rd</sup> Industrial Revolution** → computer / digital revolution

→ rise of computers

→ Internet

→ robotics in manufacturing etc. etc.  
→ Way more automation.

catalyzed by development of semiconductors.

1960 -

#### 4) 4th Industrial Revolution

- 'True' internet → internet being everywhere and being used by everyone (new normal)
- bridging physical & digital environments → cyber-physical systems (CPS)
- Advanced robots → enable industry 4.0 → automation + optimization in new ways.

\* Industry 4.0 ⇒

name given to current trend of automation & data exchange (in manufacturing technologies)

Change from physical → cyber-physical in manufacturing.

• 4.0 → CPS, IIoT, cloud / cognitive computing.

• products ↔ manufacturing process

network to communicate → enable 4.0 industry.

[Creates value & optimizes real time]

CPS source that hosts capabilities → enables Industry 4.0 to thrive → smart factories.

\* Represents an organization that controls on-ground value chain]

- has more automation than 3<sup>rd</sup> IR
  - CPS (bridging gap)
  - shifting focus to 'production' depending on 'latest intelligent products'
  - product customization / personalization

## \* WHY IS INDUSTRY 4.0 NEEDED?

- Business is increased to a level of other tech savvy rivals
  - greater resources
  - greater visibility
  - easier to identify minor issues & before they turn into bigger problems.
  - better communication
  - rich analytics (timely as well)
  - helps digitising → makes information relevant
- \* • improves overall customer satisfaction
- \* • better planning of inventory / finances, management, quality / execution / customer relationship
  - flexible & consistent view of business operation
  - tailored production
  - getting real time insights → faster business decisions.

[ANSWER]

## REASONS TO ADOPT INDUSTRY 4.0?

- 1) Higher productivity →
  - helps organise
  - helps work efficiently.
  - increases production
  - reduces waste
  - ↑ customer satisfaction
  - Efficiency ↑ → faster decision making.
- 2) Agile Process →
  - helps business (process etc)  
especially in volatile environment
  - effectively manages  
change and uncertainties
  - change rapidly &  
unpredictably, especially  
for the worse
- 3) Reduced costs →
  - increase efficiency
  - reduce waste → better utilisation of resources
  - ↑ organisation
  - ↓ operating costs
  - higher automation → reduce labour cost  
(better output)
- 4) Increased Revenues →
  - ensures better R.O.P
  - ↑ customer satisfaction →
    - increased revenue, stable  
(better situation in  
the market place)
  - return of investment  
(better return in  
form of efficiency &  
profit)

- automation | organisation (AT) → better quality products  
→ increased profit.

- 5) Better workplace →
- better workplace number  
(due to technology)
  - CPS ensures better results  
(leads to development of organisation)

- 6) Improved communication →
- adopting Industry 4.0 → real time analysis

- 7) Customer Satisfaction →
- helps meet customer satisfaction & demands
  - provide quality product at low cost
  - analyse data collected from customers
- ↓
- Data is analysed & studied
- ↓
- Shared across various departments
- ↓
- transparent information
- ↓
- better decision making  
at workspace values
- ↓
- (connected work)  
environment

- increased:
  - productivity
  - speed
  - flexibility → larger no. of products can be manufactured (automation)
  - quality. Sensors etc.

can help regulate production in real time while maintaining quality

- manufacturing conditions → safety
  - more safety due to ↑ automation
  - working conditions
  - ergonomic work stations
    - designed to prevent injuries
    - thus ↑ productivity
  - environment protection
- optimized usage of resources.  
(less waste)
- more energy efficient methods

#### 4. Innovative Capability

→ more innovations due to increased possibilities.

## DESIGN PRINCIPLES OF INDUSTRY 4.0



set of guidelines which allows businesses to investigate potential transformation to industry 4.0 technologies.

### 1) Interoperability →

- shared platforms for devices / people to communicate
- combines IoT + IOP

internet  
of things

internet of  
people

ability of machine / device / sensor / people to connect & communicate with each other using IoT.

use that information → make improvements in functioning

1st step: helps. Create advanced data

1st step → connect the machines etc + workers

get advanced data resources

2nd step → integrate this data with a smart factory soln.

analyse the data in real time → (helps gain knowledge for future decision making)

basically → connect automation to human power to get advanced data

↓

feed this data to a smart factory solution

↓

get real time analytics

+ Vast amounts of data → accurate operational knowledge

↓

which helps future decision making  
can be accessed anytime - anywhere)

→ This gives all points of Industry 4.0

→ organisation / analysis

→ increased revenue

→ customer satisfaction etc.

## 2) Information Transparency →

• IoT + IIoT = IIoE (internet of everything)

↓

greater transparency

• transparency → easy to access the steps being taken or were taken. + the information being stored.

- easy to access information + clear information

~~stop bottlenecks~~  $\downarrow$  or results

powerful method for decision

~~simplifies analysis for better decision making~~

(or)

find out what is likely to  
happen in the future  
(like statistics)

basically  $\rightarrow$  helps monitor the shop floor



helps management adjust  
operations + optimize for higher  
efficiency



gives clear view into your  
operation



more information can be  
collected



helps make more effective  
and long lasting improvements

!!!

essentially  $\rightarrow$  this information shouldn't be  
~~hidden~~ hidden from people who need it the  
most.  $\Rightarrow$  IT NEEDS TO BE 'TRANSPARENT'

### 3) Technical Assistance → ~~available for solving urgent problems~~

- ability of CPS to support humans

↓

visualising information

↓

such that solving urgent problems / informed decisions  
on short notice

↓

simple + effective

ex: work instruction software → digital solution

method to communicate intricate  
task sequences

operational procedures

often used during employee  
training  
(CPS)

- helps humans to physically

(ex: unpleasant, exhausting, unsafe)

↓

ex: robots in factories reduces injuries

- helps manufacturers analyse data and help in  
taking better work related decisions

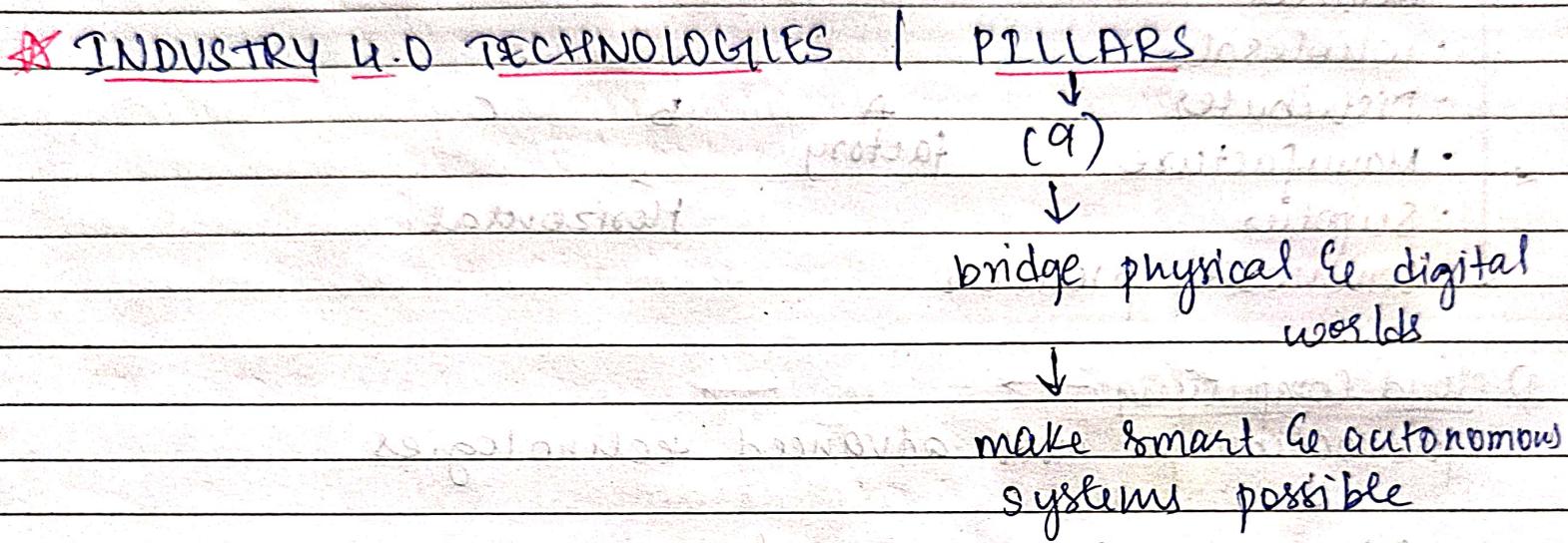
## ii) Decentralization of Decisions → *multiple decision points*

- CPS must take decisions independently  
↓  
will manage overseeing material needs autonomously through decentralized network of IoT and cloud computing
  - lets machines take decisions with little to no human interaction  
↓  
makes problem solving, adjustments etc an automated system
- basically → CPS will take decisions independently instead of giving tasks to humans
- ↓  
makes the whole system fast
- (problem solving, adjustments, calibration etc)
- =

## Design Principles → *multiple decision points*

- ability of machines / objects / people to coordinate activities
- ability to create virtualised view → see how new equipment / process will affect work.
- ability to make autonomous decisions
- collection of realtime data.

- ) ability to allow free information flow within & in b/w businesses.
- ) ability to flexibly adapt to changing requirements and industry needs.

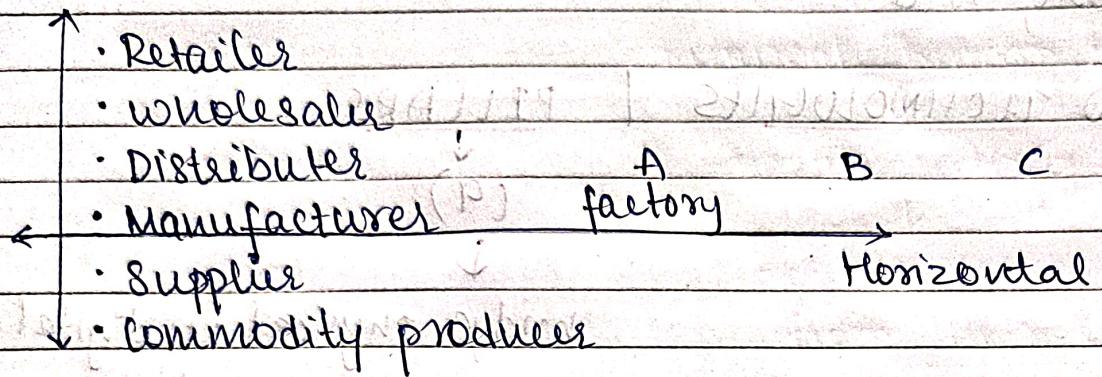


### 1) Big Data and AI analytics →

→ AI & ML are applied  
extremely large & complex data sets  
analysed to improve decision making  
cannot be easily managed  
+  
collected from wide range of sources.  
↓  
Automation in every area.

## 2) Horizontal and Vertical Integrations →

vertical



## 3) Cloud Computing →

- foundation for most advanced technologies

gives businesses means to innovate

- the data that fuels industry 4.0 → resides in the cloud
- CPS at the core of 4.0 use the cloud to communicate and coordinate.

## 4) Augmented Reality →

- overlays digital content on real environment
- employees can use smart glasses / mobiles etc to visualise real time IoT data etc.

## 5) Industrial internet of things → (IIoT)

- IoT & IIoT used so much that terms are used interchangeably
- most physical things in H.O → devices, machinery, robots, equipment
  - ↓
    - use sensors / RFID tag to provide real time data
  - ← about condition, performance, location
  - lets companies run smoother instances (etc)
  - terms of management,
  - supply chain, organisation, etc
  - preventing equipment downtime,
  - not letting product quality decrease.

## 6) Additive Manufacturing / 3D printing →

- with 3D printing
  - ↓
    - parts / products can be stored as files in virtual inventories
    - can be printed on demand of need [reduces both cost & transportation distances]
  - initially used as a prototyping tool
    - now - mass customization to distributed manufacturing

7) Autonomous Robots → new generation  
↓  
programmed to be able to perform tasks with minimal human intervention  
↓  
having cutting edge technology (AI, sensors etc)  
act on information received from their surroundings

8) Simulation / Digital twins →  
↓  
virtual simulation of a real world machine / product / process etc  
↓  
allows businesses to better understand / analyze and improve performance of industrial system / process.

ex: asset operator → uses a digital twin to identify specific malfunctioning part.

9) Cybersecurity → increased connectivity + Big Data  
↓  
effective cybersecurity → very important companies can automate threat detection, prevention and response and minimize the risk of data breach (zero trust architecture)

## \* ROAD TO INDUSTRY 4.0

- 1) Design - Engineering of new product introduction
- 2) Buy - Strategic sourcing or procurement
- 3) Build - Manufacturing operations or inventory
- 4) Sell - Logistics or distribution
- 5) Maintain - After sales

→ Overcoming challenges in legacy manufacturing systems →

- moving onto Industry 4.0 can seem challenging for many organisations from decades-old legacy systems. (which are highly complex but also critical for day-to-day operations of the business)