Industry 4.0

Topic: Industry 4.0 Environment and Design Principle

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INTRODUCTION

- Conventional Automation :
  - use of machines, robotics, and control systems to perform tasks with minimal human intervention.
  - replacing manual labor and streamlining specific processes, without extensive connectivity or data-driven insights.
- Automation in Industry 4.0:
  - leveraging digital technologies, connectivity, and data analytics to create smart, flexible, and interconnected systems.
  - characterized by the integration of cyber-physical systems, the Internet of Things (IoT), cloud computing, artificial intelligence (AI), big data analytics, and machine learning.

CHARACTERISTICS OF CONVENTIONAL AUTOMATION

- Task-specific automation: Machines and robots are programmed to perform specific tasks repeatedly, such as assembly line operations or material handling.
- Limited connectivity: Conventional automation systems often work in isolation and have limited communication and connectivity with other machines or systems.
- Centralized decision-making: Decisions are usually made by human operators or a centralized control system based on pre-programmed instructions or simple rule-based logic.
- Limited data utilization: While data may be collected during automation processes, it is not extensively used for real-time monitoring, analysis, or optimization.

CHARACTERISTICS OF INDUSTRY 4.0

- **Cyber-physical systems:** Physical machines, devices, and sensors are connected to digital systems, enabling real-time data exchange and decision-making.
- **Internet of Things (Virtualization):** Connected devices and sensors gather vast amounts of data from various sources, facilitating seamless communication and collaboration between machines, humans, and systems. This enables a virtual copy of the Smart Factory which is created by linking sensor data (from monitoring physical processes) with virtual plant models and simulation models
- **Decentralized decision-making:** Intelligent systems and algorithms empower machines to make autonomous decisions based on real-time data, enabling agile and adaptive manufacturing processes.

CHARACTERISTICS OF INDUSTRY 4.0 CONT..

- **Data-driven insights (Real-Time Capability)**: Advanced analytics and machine learning algorithms analyze the collected data to generate actionable insights, optimize operations, predict maintenance needs, and improve overall performance.
- **Enhanced human-machine interaction (Service Orientation):** Industry 4.0 envisions humans and machines working together harmoniously, with humans focusing on complex decision-making, creativity, and problem-solving, while machines handle repetitive and data-intensive tasks.
- **Customization and flexibility (Modularity):** Industry 4.0 enables the efficient production of highly customized products through flexible manufacturing processes that can adapt to changing customer demands.

DESIGN PRINCIPLES

- Inter-Connectivity
- Information Transparency
- Decentralized Decision Making
- Flexibility and Modularity
- Cybersecurity
- Human Machine Interaction
- Continuous Improvement

EXAMPLES OF PRODUCT EVOLUTION: CONNECTED AND SMART PRODUCTS

Philips Lighting

Users can control Philips Lighting hue lightbulbs via smartphone, turning them on and off, programming them to blink if they detect an intruder, or dimming them slowly at night.

Medtronic

Medtronic's implanted digital blood glucose meter connects wirelessly to a monitoring and display device and can alert patients to trends in glucose levels requiring attention.

Ralph Lauren

Ralph Lauren's Polo Tech Shirt, available in 2015, streams distance covered, calories burned, movement intensity, heart rate, and other data to the wearer's mobile device.

Babolat

Babolat's Play Pure Drive product system puts sensors and connectivity in the tennis racket handle, allowing users to track and analyze ball speed, spin, and impact location to improve their game.

Harvard Business Review

Examples
SIEMENS

- German manufacturing giant Siemens, an industrial user, is implementing an Industry 4.0 solution in medical engineering. For years, artificial knee and hip joints were standardized products, with engineers needing several days to customize them for patients. Now, new software and steering solutions enable Siemens to produce an implant within 3 to 4 hours.

Examples

TRUMPF

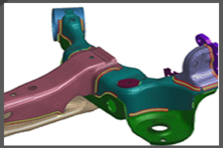
- German toolmaker Trumpf, an Industry 4.0 supplier and worldwide market leader of laser systems, has put the first "social machines" to work. Each component is "smart" and knows what work has already been carried out on it. Because the production facility already knows its capacity utilization and communicates with other facilities, production options are automatically optimized.

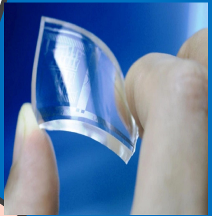
EXAMPLES

GE

- Predix, the operating system for the Industrial Internet, is powering digital industrial businesses that drive the global economy. By connecting industrial equipment, analyzing data, and delivering real-time insights, Predix-based apps are unleashing new levels of performance of both GE and non-GE assets.

MEGA TRENDS (PHYSICAL)





- 3D Printer: Manifesting physical objects based on digital specifications (medical implants)
- New Materials: Ligter, stronger, recyclable, (Example: Graphene, theroset plastics)
- Advanced Robotics: Uses for automation, agriculture, nursing
- Lean Manufacturing technology
- Driverless vehicles (Drone)

MEGATRENDS (DIGITAL)

- Internet of Things
- RFID: Tracking, asset management
- Bitcoin: digital currency
- Blockchain: securing banking transactions
- Uber model of transportation: Sharing and pooling the resources for better utilization (storage, computing)

MEGATRENDS (BIOLOGICAL)

- Genetic sequencing
- DNA writing
- Recommender system (IBM Watson)
- Cell Modification
- Genetic Engineering(CRISPER)

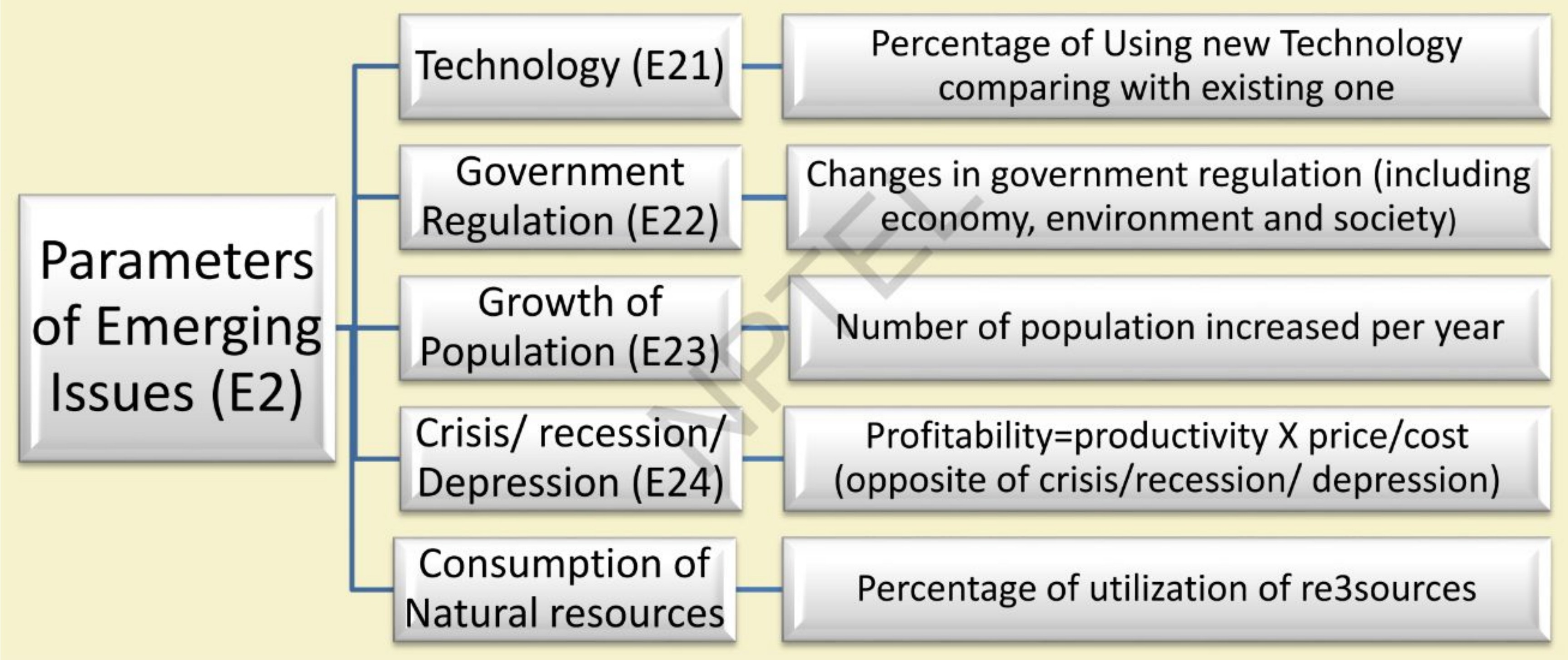
SUSTAINABILITY AND I4.0

- Continue at a fixed price
- Energy efficiency, Resourse conservation, Low-waste production
- Globalization: Bussiness model, Emerging markets, Supplychain Management, Adapting state-of-art ICT
- Energy consumption: from non-renewable to renewable
- Government Regulations: Environment guidelines, Privacy regulations, emplyement & labor rule, advertisement regulations, safety and health guidelines
- Economic crises/ recession

TYPES OF WASTES

- Transportation – Excessive movements of people for materials or information
- Waiting – Period of inactivity of people for material or information
- Motion – Non value-added movement of people
- Inventory – Cost of inventory such as raw materials, work in process, finished goods
- Over-processing – Doing more work in product than customer values
- Defects – Defects can be in products or paper works
- Overproduction – Producing more product sooner than the customers ready for

SUSTAINABILITY ASSESSMENT OF EMERGING ISSUES



SUSTAINABILITY ASSESSMENT

- Sustainability/Sustainable development
  - ${}^{S}/_{SD_{E2}} = f(E21, E22, E23, E24, E25)$
  - ${}^{S}/_{SD_{E2}} = (I_{E21}^{Y_{E21}} . I_{E22}^{Y_{E22}} . I_{E23}^{Y_{E23}} . I_{E25}^{Y_{E24}} . I_{E25}^{Y_{E25}})$
  - Where $I_{E2i} = S_{E2i}/E2i$,
  - S_{E2i}= The change towards the sustainability
  - Y_{E2i}= Exponent of the change towards sustainability (S_{E2i}) of $E2i$

INDUSTRY 4.0
RELEVANCE AND IMPLICATIONS IN INDIAN INDUSTRY

I4.0 IN INDIAN

Smart Advanced Manufacturing and Rapid Transformation Hub (SAMARTH)

- Five CEFC (Common Engineering Facility Center) Projects are:
  - Center for Industry 4.0 (C4i4) Lab Pune
  - IITD-AIA Foundation for Smart Manufacturing
  - I4.0 India at IISc Factory R & D Platform
  - Smart Manufacturing Demo & Development Cell at CMTI
  - Industry 4.0 projects at DHI CoE in Advanced Manufacturing Technology, IIT Kharagpur

SUCCESSFUL STORIES

https://www.samarthudyog-i40.in/documents

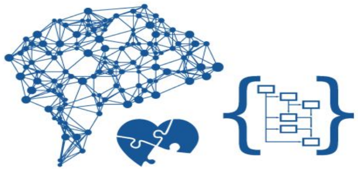
TOP 10 SKILLS TO BE RELEVANT IN INDUSTRY 4.0

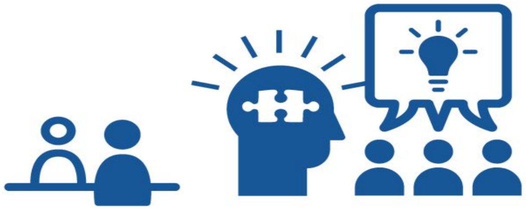
in 2020

1. Complex Problem Solving
2. Critical Thinking
3. Creativity
4. People Management
5. Coordinating with Others
6. Emotional Intelligence
7. Judgment and Decision Making
8. Service Orientation
9. Negotiation
10. Cognitive Flexibility

in 2015

1. Complex Problem Solving
2. Coordinating with Others
3. People Management
4. Critical Thinking
5. Negotiation
6. Quality Control
7. Service Orientation
8. Judgment and Decision Making
9. Active Listening
10. Creativity





Source: Future of Jobs Report, World Economic Forum

Thank You