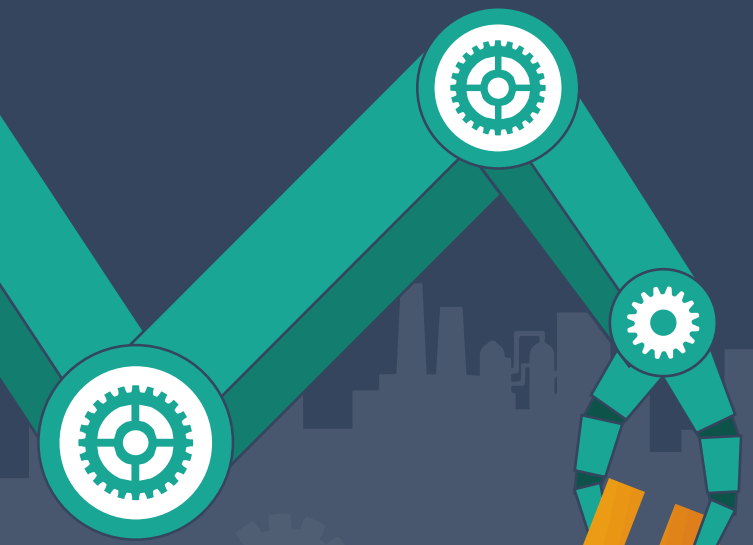
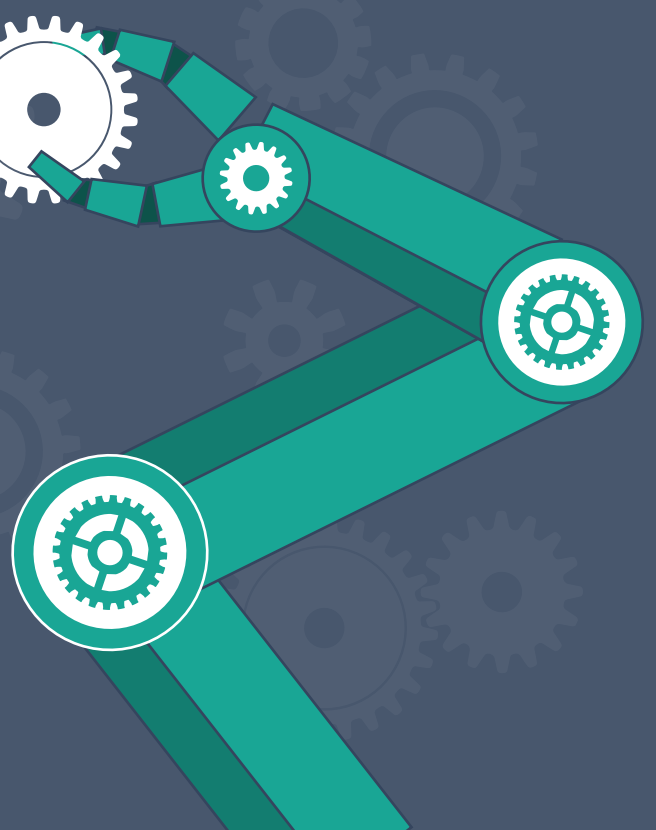


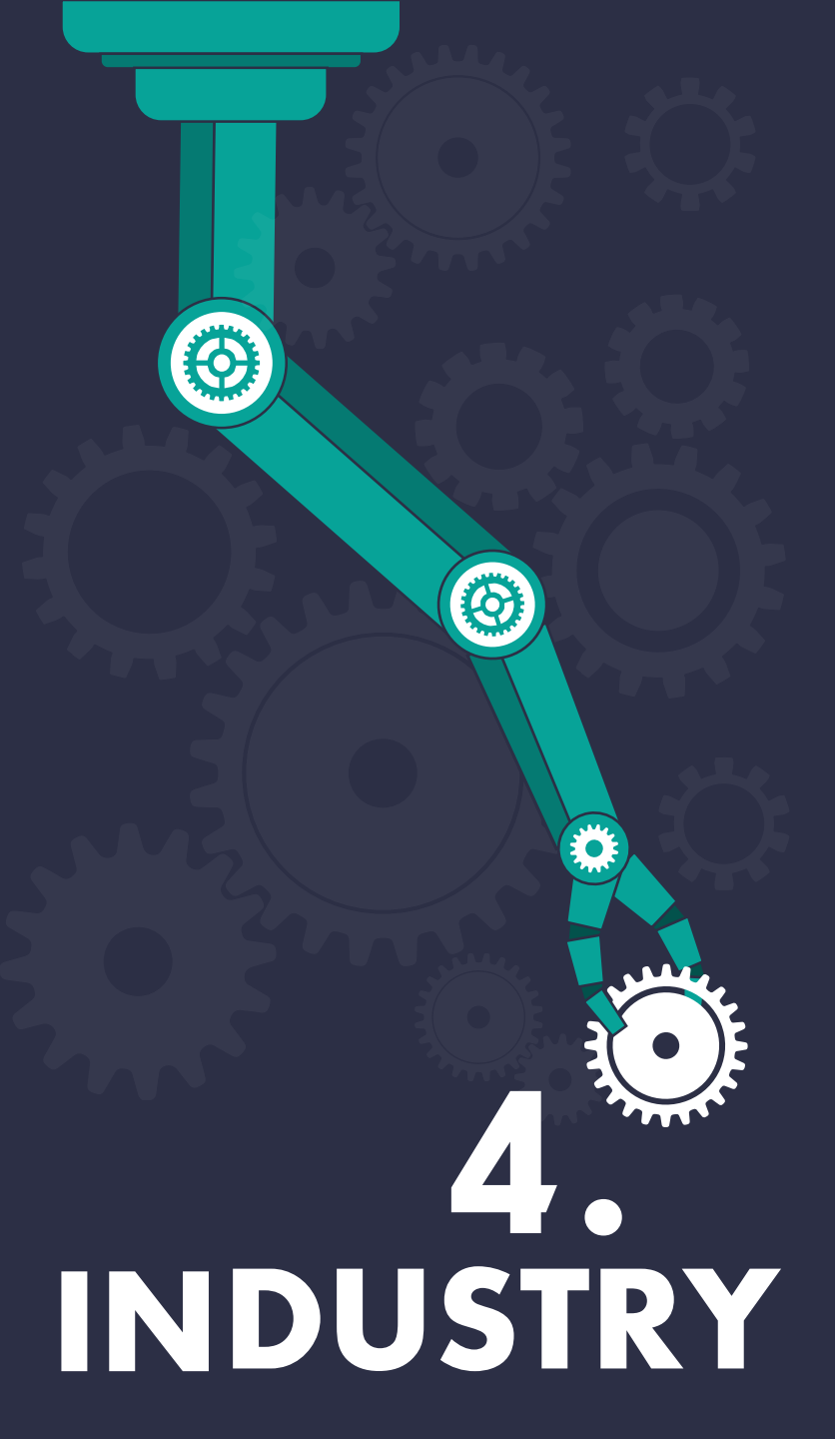
INDUSTRY 4.0

Technologies and methods that shaped 4th Industrial Revolution

Dr Marija Jankovic, CERTH/ITI

Thessaloniki, Greece 23 October 2023





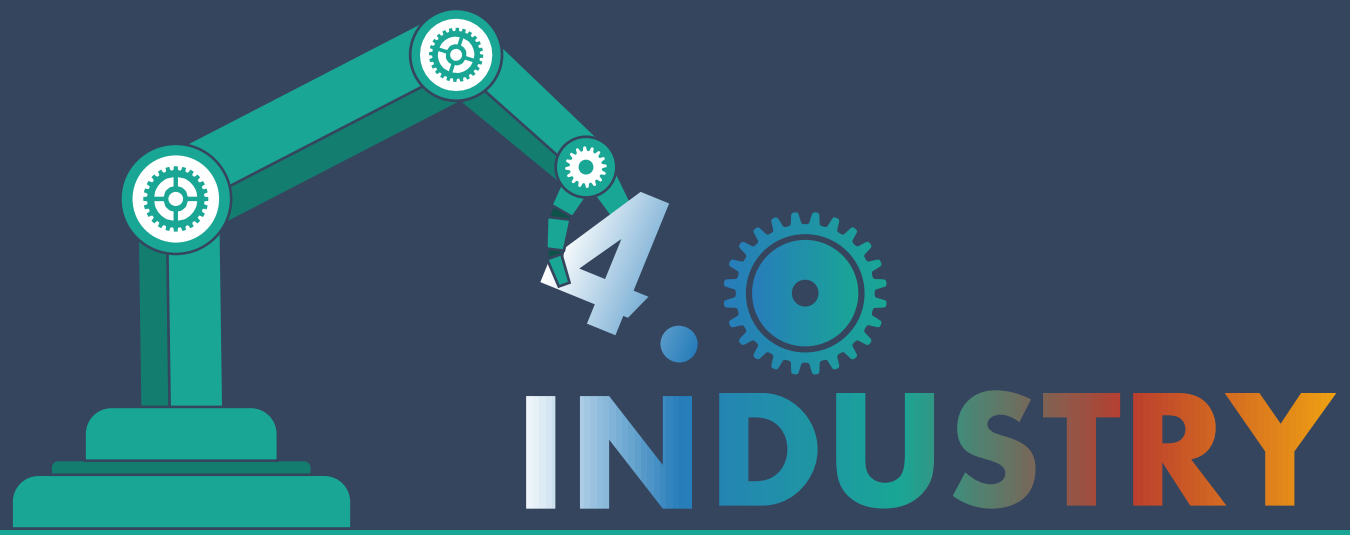
Agenda

01 Industry 4.0 Revolution

02 Industry 4.0 Key Technologies

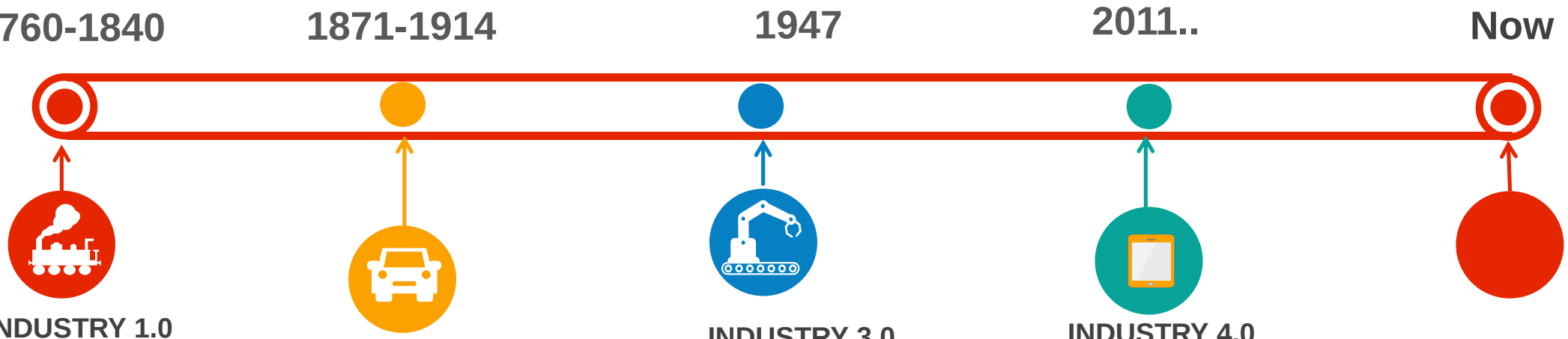
03 Industry 4.0 Methods and Dimension

04 Industry 4.0 Enablers



Industry 4.0 Revolution

Industrial Revolution



INDUSTRY 1.0

Mechanical systems
First mechanical **loom** (1745).
Steam-based mechanical production (1771).
Automatic **four mills** (1785)

INDUSTRY 2.0

Wide adoption of **electricity-based** mass production.
First **assembly line**.
Telegraph networks. and **railroads**

INDUSTRY 3.0

Digital revolution era.
First **programmable controller**.
Controller-based **automation.**

INDUSTRY 4.0

Industrial automation.
Emergence of **Smart Factories** with distributed production and control.
Rise of **mass production**.
CPS, IoT, Cloud, AI, etc.

INDUSTRY 5.0?

Seamless integration of humans and machines.
Focus on **human-machine** collaboration.
Society 5.0.

4th Industrial Revolution

Prof. Klaus Schwab

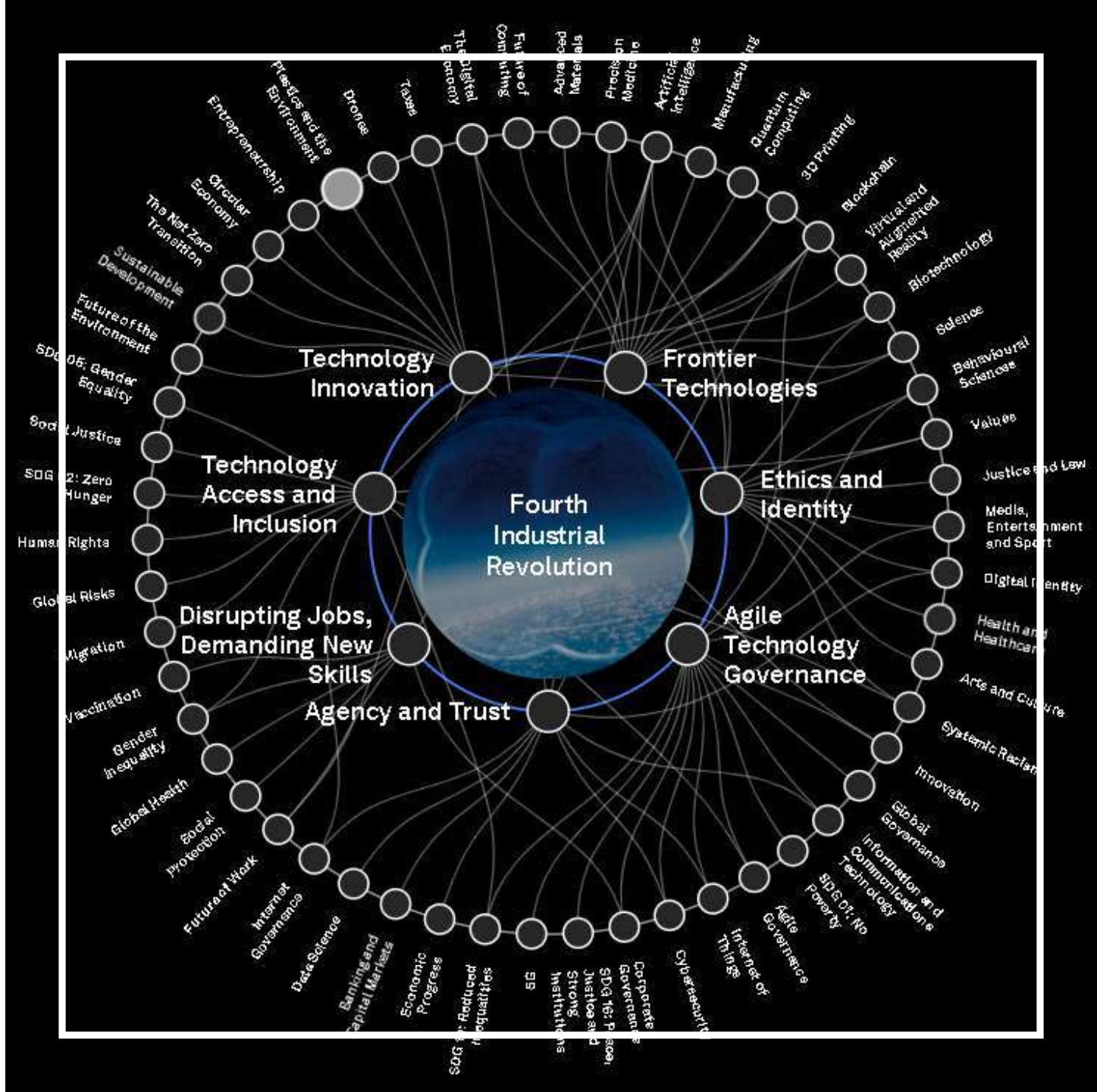
Founder and Executive Chairman of the World Economic Forum

> “THE FOURTH INDUSTRIAL REVOLUTION WILL AFFECT THE VERY ESSENCE OF OUR HUMAN EXPERIENCE.”

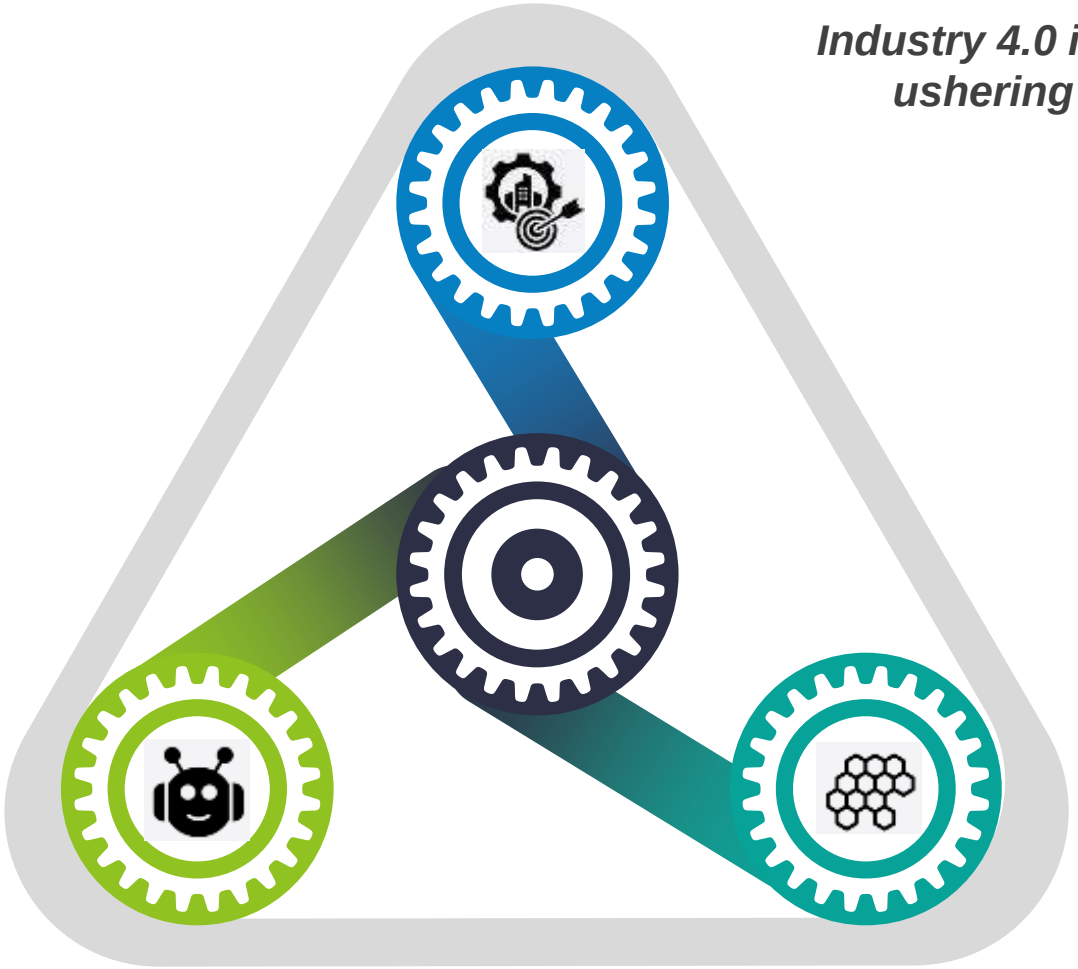
- **Fundamental change -** how we **create**, **exchange**, and **distribute value**.
- **Technological shift -** merging our **physical**, **digital**, and **biological** worlds into one.
- **Driving technologies -** such as artificial intelligence, augmented reality, robotics, and 3-D printing offer innovative solutions for longstanding challenges
- **Emphasis on collaboration –** need for strategies that prioritize **empowerment** and **collaboration** and help build a more sustainable foundation for social and economic development.

4TH INDUSTRIAL REVOLUTION

World Economic Forum
https://intelligence.weforum.org/topics/a1Gb0000001RIhBEAW



Industry 4.0 Components



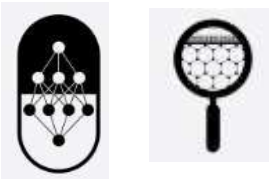
Industry 4.0 is the synergy of digital and physical realms in manufacturing, ushering in more intelligent, adaptable, and streamlined processes.

NEW TECHNOLOGIES

3D printing, IoT, advanced robotics, etc.

NEW MATERIALS

Materials developed using cutting-edge technologies, often at bio or nano scales



NEW METHODS AND PROCESSES

Data-Driven Production: Incorporating AI, synthetic biology, and more.
Organizational Advancements: Emphasizing new knowledge, skills, and structures.

Design principles of Industry 4.0

INTERCONNECTION

- Various **machines**, **CPS**, **sensors, devices, people;**
- To create a network of **real-time interaction** and **data exchange;**
- To provide **relevant** and **timely** information for decision-making.

INFORMATION TRANSPARENCY

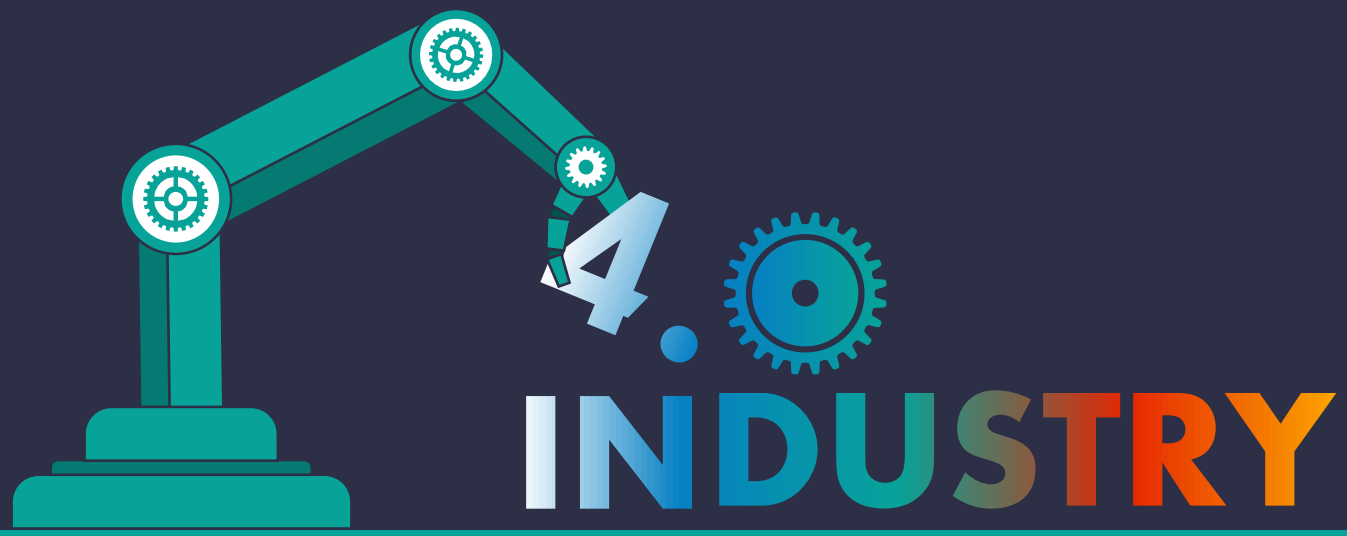
- The massive amount of data generated through interconnection is made **transparent** and **accessible**;
- **Useful** & and **actionable** insights to operators, analysts, decision-makers
- Quickly identify **opportunities**

TECHNICAL ASSISSTANCE

Should **collect** and **visualise** gathered information.
Efficient decisions
Urgent issues
Short notice

DECENTRALIZED DECISIONS

- Centralized decision-making - **bottleneck**
- Higher decisions are **centralized**
- **Day-to-day** operational decisions are delegated
- CPS can make autonomous decisions in exceptional situations.



Industry 4.0 Technologies

Industry 4.0 Technologies

Artificial Intelligence

Industrial Internet of Things

Augmented Reality

Virtual Reality

Robotics

Big Data

Computer Vision

Blockchain

Machine Learning

Digital Twins & Simulations

Cyber Security

Smart Hardware Solutions

Additive Manufacturing

Decision Support

INDUSTRIAL

Internet of Things

IIOT

Leverages interconnected devices and systems within an industrial framework to streamline operations and enhance productivity.

- Real-time communication
- Data sharing
- Collaborative interfaces

BENEFITS

- Operational Efficiency
- Predictive maintenance
- Informed decisions

APPLICATIONS

- Smart factories
- Connected logistics
- Energy management

KEY TRENDS

- Edge Computing
- AI and ML integration
- Enhanced cybersecurity
- Digital twins
- Industry-specific IIoT solutions

Cyber-Physical Systems

CPS

Systems that involve tight coordination and integration between

- Computation
- Networking, and
- Physical processes.

BENEFITS

- Bridging the gap between virtual and physical worlds
- Real-time monitoring and control
- Enhanced adaptability, autonomy, efficiency, and functionality

APPLICATIONS

- Smart grids
- Autonomous vehicle systems
- Medical monitoring
- Advanced Manufacturing

ARTIFICIAL INTELIGENCE

A I

A branch of computer science that equips machines with the capability to simulate human intelligence processes, including

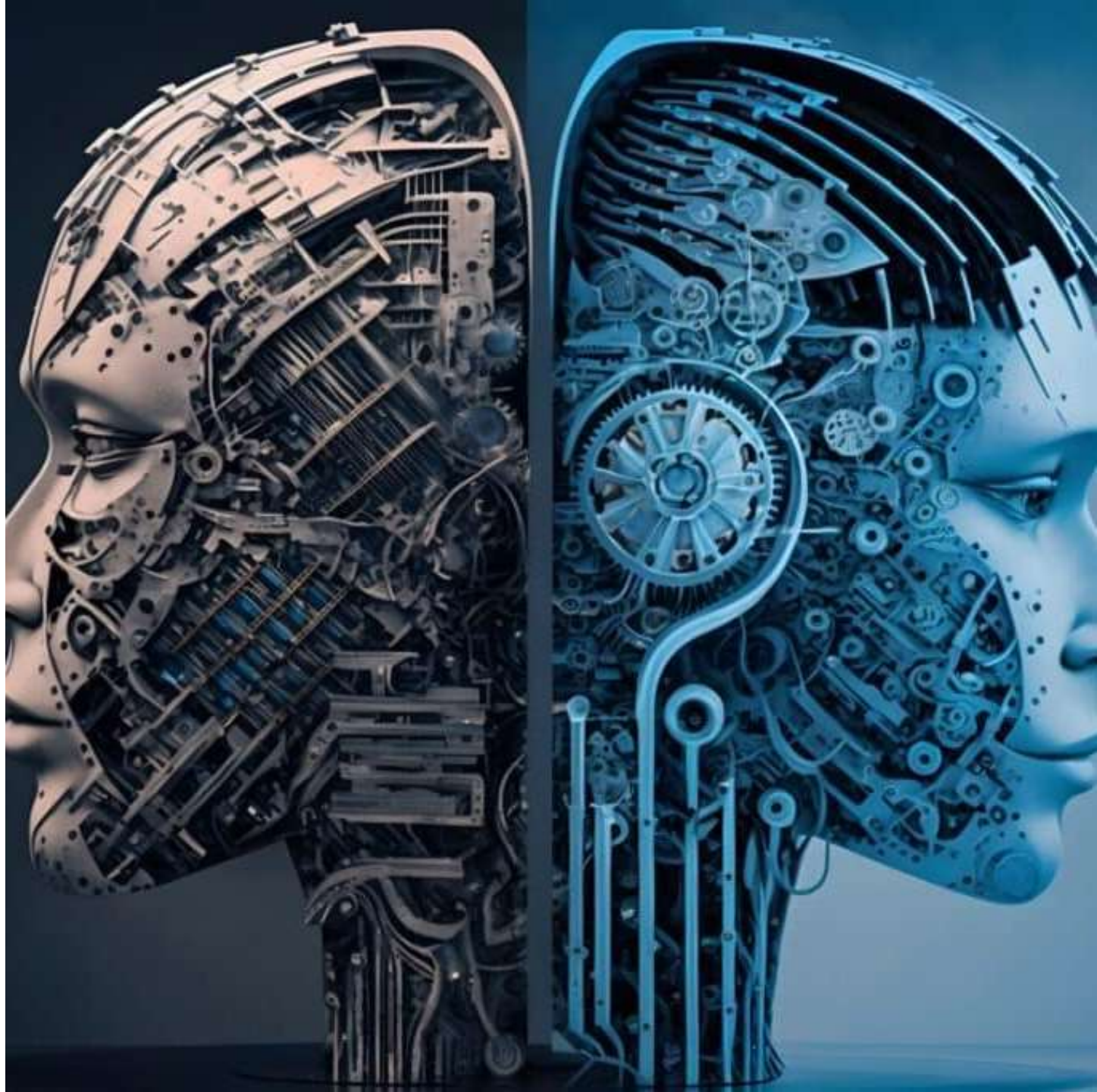
- learning,
- reasoning, and
- self-correction.

BENEFITS

- Enhances efficiency across various industries
- Offers innovative problem-solving techniques
- Reduces operational costs through automation
- Enhances user experience with personalised content
- Boosts revenue with data-driven strategies

APPLICATIONS

- Natural Language Processing (NLP)
- Recommendation systems
- Virtual assistants: Siri, Alexa, and other voice-activated helpers
- Predictive analytics
- Robotics and Cobots
- Image recognition in quality control



ADVANCED ROBOTICS

Machines designed to execute tasks autonomously or with human intervention

BENEFITS

- Increased production speed
- Enhanced precision and consistency
- Safe execution of hazardous tasks

APPLICATIONS

- Automated assembly lines
- Drones for surveillance
- Collaborative robots in manufacturing

KEY TRENDS

- Edge Computing
- AI and ML integration
- Enhanced cybersecurity
- Digital twins
- Industry-specific IIoT solutions

A D I T I V E
MANUFACTURING

A manufacturing process in which material is added layer by layer to build a three-dimensional object from a digital model

BENEFITS

- Rapid prototyping
- Customization and personalisation of products
- Reduction in material waste
- Complex geometries not achievable with traditional methods

APPLICATIONS

- Aerospace components
- Medical implants
- Custom jewelry
- Architectural models, and bespoke consumer goods.

KEY TRENDS

- Increased adoption in production
- Development of new materials
- Advances in hybrid manufacturing
- Increased use of multi-material printing

AUGMENTED REALITY

AR integrates and overlays virtual data on the real world. It enhances the user's current perception of reality by superimposing computer-generated information on their view.

BENEFITS

- Enhanced user experience
- Real-time data visualization
- Interactive training and education
- Improved navigation and object recognition

APPLICATIONS

- Retail (virtual try-ons)
- Maintenance and repair guidance
- Gaming
- Medical procedures and real estate tours

KEY TRENDS

- Mobile AR
- Cloud AR
- Wearable AR
- AR in education and retail

VIRTUAL REALITY

A digital technology that immerses users in a fully artificial environment, allowing them to interact with 3D worlds using specialized hardware.

BENEFITS

- Immersive experiences
- Safe environment for training and simulations
- Enhanced gaming and entertainment
- Therapeutic applications (e.g., PTSD treatment)

APPLICATIONS

- Video games
- Architectural visualisation
- Medical training
- Virtual tourism
- Social VR platforms.

D I G I T A L
T W I N S

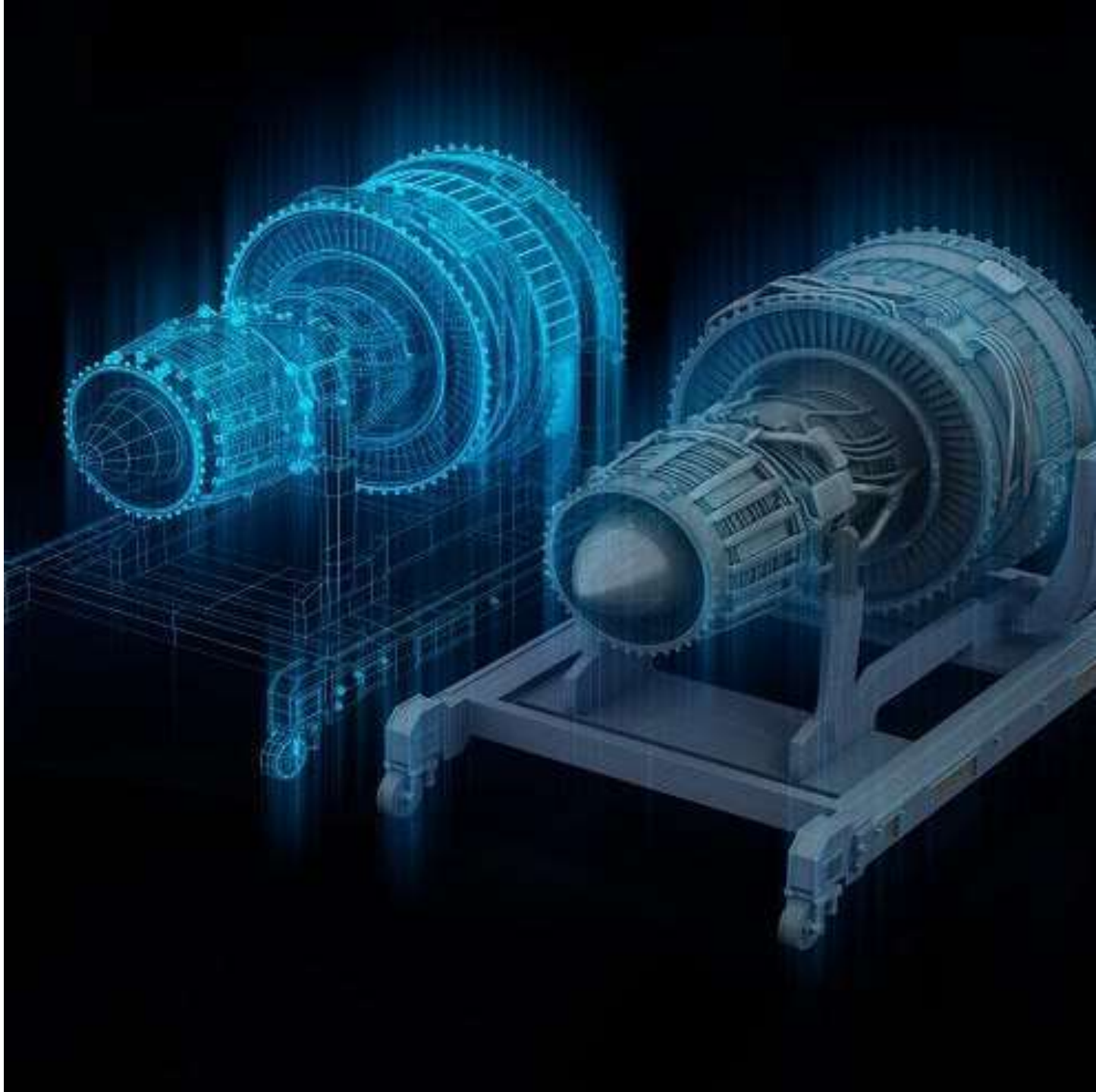
-Virtual replica of physical entities, processes or systems;
- They are merged with real-time data gathered from sensors, facilitating dynamic monitoring, analysis, and fine-tuning.

BENEFITS

- Real-time monitoring and diagnostics
- Predictive maintenance and prognostics
- Scenario testing and optimization without impacting the real entity
- Enhanced decision-making based on accurate, real-time data

APPLICATIONS

- Industrial equipment
- Smart cities
- Healthcare (patient monitoring)
- Infrastructure management, and
- Product lifecycle management.



C L O U D
C O M P U T I N G

A system where data and programs are stored and accessed over the internet instead of on a local computer, allowing users to access their data anytime, anywhere.

BENEFITS

- Scalability: Adjust resources based on demand.
- Cost-effective: Only pay for what you use.
- Flexibility: Access from anywhere with an internet connection.
- Security: Advanced security protocols to protect data.
- Collaboration: Multiple users can collaborate in real-time.

APPLICATIONS

- Web-based applications (e.g., Google Drive, Office 365).
- Backup and disaster recovery.
- Big data analytics.
- Virtual desktops.

KEY TRENDS

- Hybrid cloud solutions.
- Containerization (e.g., Docker, Kubernetes).
- Serverless computing.

BLOCKCHAIN TECHNOLOGY

A decentralized, distributed ledger technology that records transactions across multiple computers in a way that ensures the data is secure, transparent, and immutable.

BENEFITS

- Enhanced security due to cryptographic techniques
- Transparency with open, verifiable transactions
- Reduction of intermediaries, leading to faster and cheaper transactions
- Immutable records preventing tampering or alteration

APPLICATIONS

- Cryptocurrencies (e.g., Bitcoin)
- Supply chain management
- Smart contracts
- Digital identity verification and voting systems.

KEY TRENDS

- Interoperability
- Privacy and Security (Monero, Zcash, etc.)

C Y B E R
S E Q U R I T Y

The practice of protecting computer systems, networks, and data from theft, damage, or unauthorized access. It encompasses a range of technologies, processes, and practices.

BENEFITS

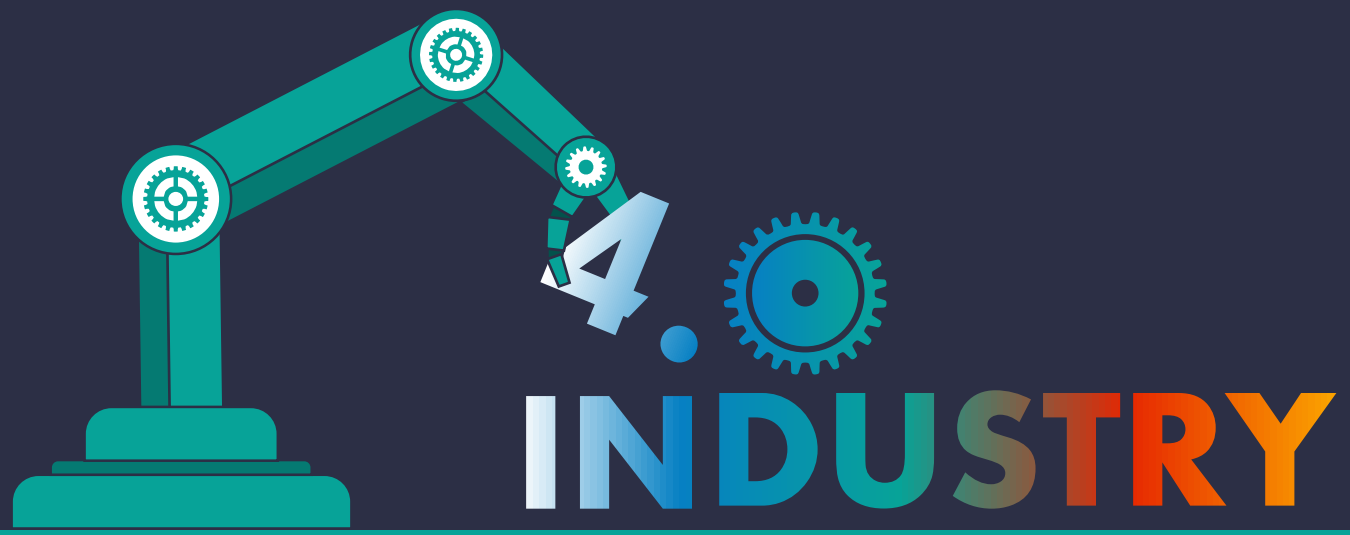
- Safeguarding sensitive data and personal information
- Ensuring business continuity and minimizing downtime
- Protecting against financial losses
- Upholding reputation and trust among stakeholders
- Compliance with regulations and laws

APPLICATIONS

- Intrusion detection systems
- Firewalls, antivirus software, encryption tools, and multi-factor authentication

KEY TRENDS

- Zero Trust Security
- IoT Reference Architectures
- Multi-factor Authentication



Industry 4.0 Methods and Dimensions

Maturity and Readiness Models

IMPULS Industrie 4.0 Readiness 2015 (I)

Strategy and Organization, Smart Factory, Smart Operation, Smart Products, Data-driven Services, Employees

Maturity and Readiness Model for Industry 4.0 Strategy (Akdil et al, 2018)

(1) Smart Product and Services, (2) Smart Business Processes, Production, Logistics and Procurement, (3) Strategy and Organization

The Digital Transformation Assessment (IPK) (I)

Corporate strategy, Leadership and corporate structure, organization and processes, technology, product and services, supply and chain networks

Industry 4.0 Maturity Model (An Essential Scale for SMEs) (Trotta et al, 2019)

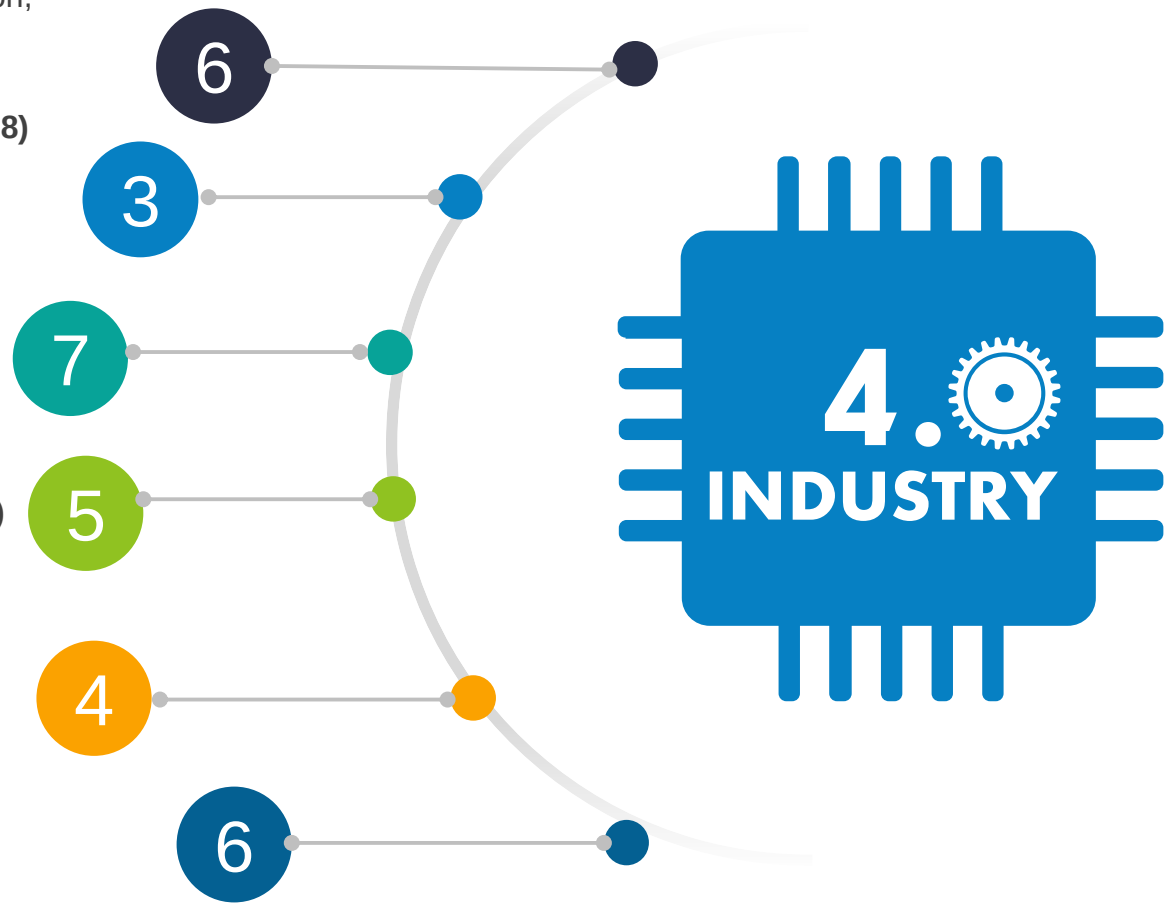
Strategy, Technology, Production, Products, and People

Maturity Level-Based Assessment Tool of Industry 4.0 for SMEs (Rauch et al,, 2020)

Operations, organization, socio-culture, and technology

A Framework for Assessing Manufacturing SMEs Industry 4.0 Maturity (Amaral et al, 2021)

Smart Products, People, Production Process, Technology, Organization, and Change



Industry 4.0 Dimensions

SMART PRODUCTS AND SERVICES

EMPLOYEES AND COMPETENCES

SMART PRODUCTION

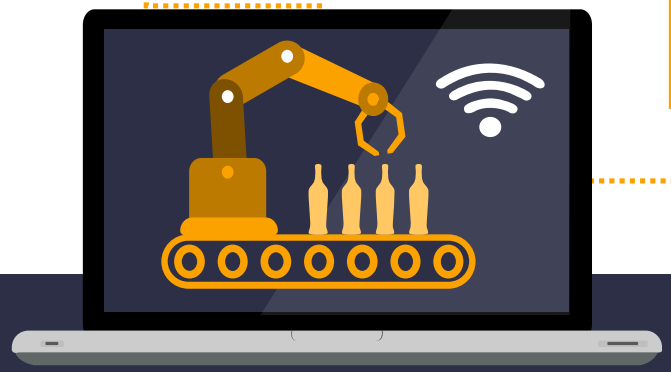
BUSINESS STRATEGY, ORGANIZATION AND PROCESSES

SMART OPERATION

Smart Products and Services

SMART PRODUCTS

Devices embedded with software and sensors – capable of connecting and communicating over the Internet;
- computing, and storing data;
- displaying status, properties, history;
- indicating maintenance operations.



SMART SERVICES

Services that aggregate and analyze data from Smart Products to offer enhanced capabilities and solutions;
Highly depended on the business context.

Q1.1 Identify the functionalities that your company's products can fulfil

Q1.2 Is the product/service capable of performing any steps in the data analysis process?

Q1.3 Is it possible to track the product through the life-cycle?

Q1.3 Advanced data analysis..

Smart Production

SMART PRODUCTION

An environment where production and logistic processes are largely autonomous, requiring minimal human interaction

Key features:

- **Real-time** data access from any location
- **Seamless integration** of manufacturing-relevant information

Digital Model &Data Usage

Equipment infrastructure & IT Systems

Key components:

- **Digital Modeling**
- **Collaborative ecosystem**
- **Data management**

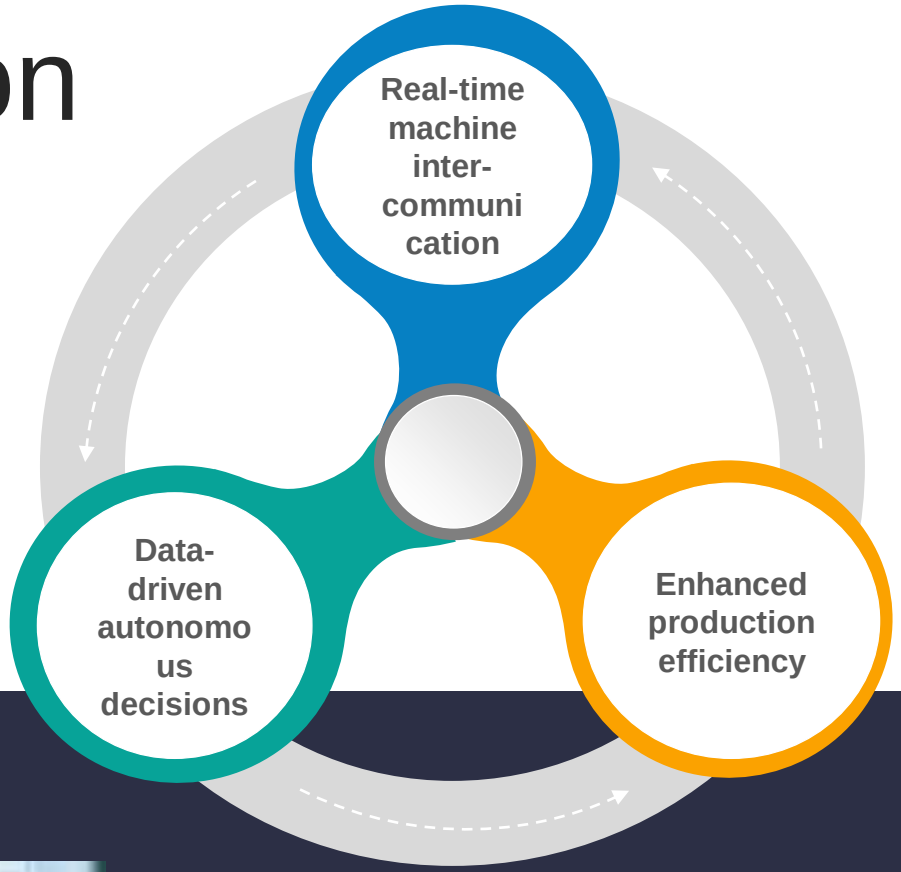
Q2.5 Do you use digital models?

Q2.3 How do you evaluate status of the equipment infrastructure?

Smart Operation

SMART OPERATION

Harnesses advanced technologies to revolutionize and optimize industrial processes.



Key technologies:

- IoT
- Artificial Intelligence
- Big Data Analytics
- Cloud Computing

Q2.5 Does the production process respond automatically in real-time?

Business Strategy, Organization and Processes

BUSINESS STRATEGY

A plan of action that companies use to achieve their goals and outperform competitors.

BUSINESS ORGANIZATION

The structure of a company that defines roles and responsibilities.

BUSINESS PROCESSES

Step-by-step methods or procedures that companies follow to carry out tasks.

Strategy implementation:
Assessing the current level of Industry 4.0 strategy execution

Technology and Innovation Management:
Effective utilization and management of cutting-edge technologies and innovations

Strategic review:
Continuous monitoring of the strategy through a set of dedicated indicators.

Investment Activity:
Analyzing financial commitment and investments geared towards Industry 4.0 initiatives

Employees and Competences

Digital transformation reshapes workplaces, bringing new challenges and opportunities.

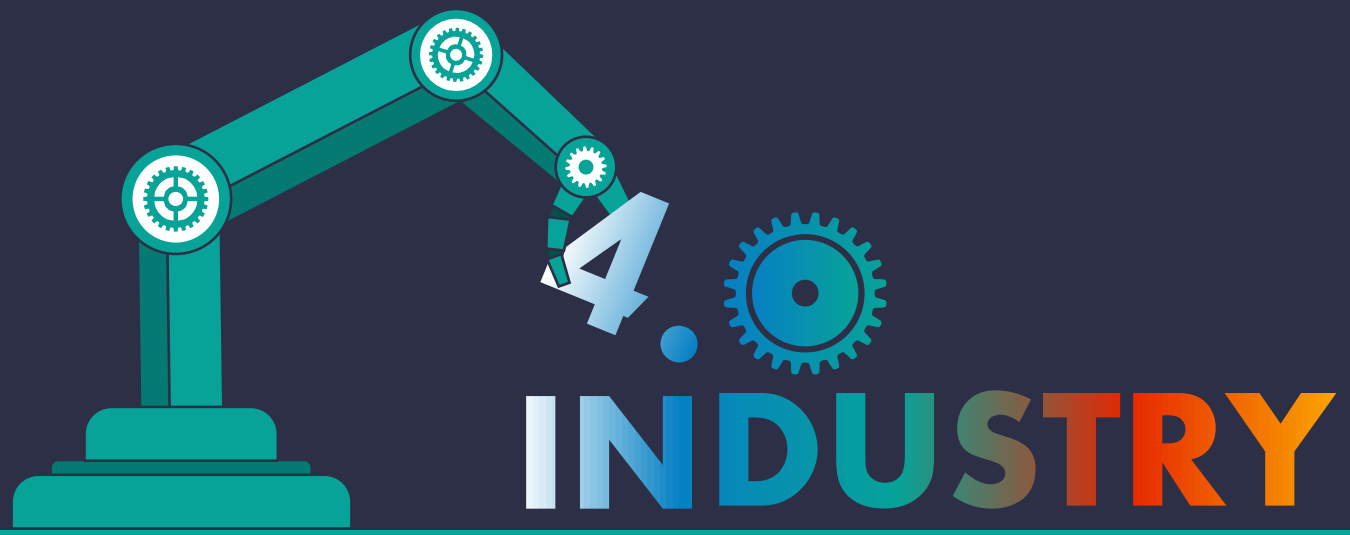
Employees face the need to adapt and acquire new skills to fit into the changing digital landscape

Training and Education:

- Companies must prioritize continuous training and education for their employees.
- This ensures that the workforce remains competent and can leverage the advantages of digital tools.

Readiness Assessment:

- Evaluation of the skill levels and willingness to learn
- Regular assessment provide insights for tailored training programs



Industry 4.0 Enablers

INDUSTRY

ENABLERS

TECHNOLOGY

-Software
-Hardware
-Connectivity/Communication
-Digitalization

ORGANIZATION

- Strategic roadmap
- Definition of digital roles
- Change management
- Integration in production
- Integrated manufacturing organization

HUMAN

- Continuous Digital Awareness
- Collaboration
- Training Competences
- Efficient Communication
- Innovation Skills

Thank You

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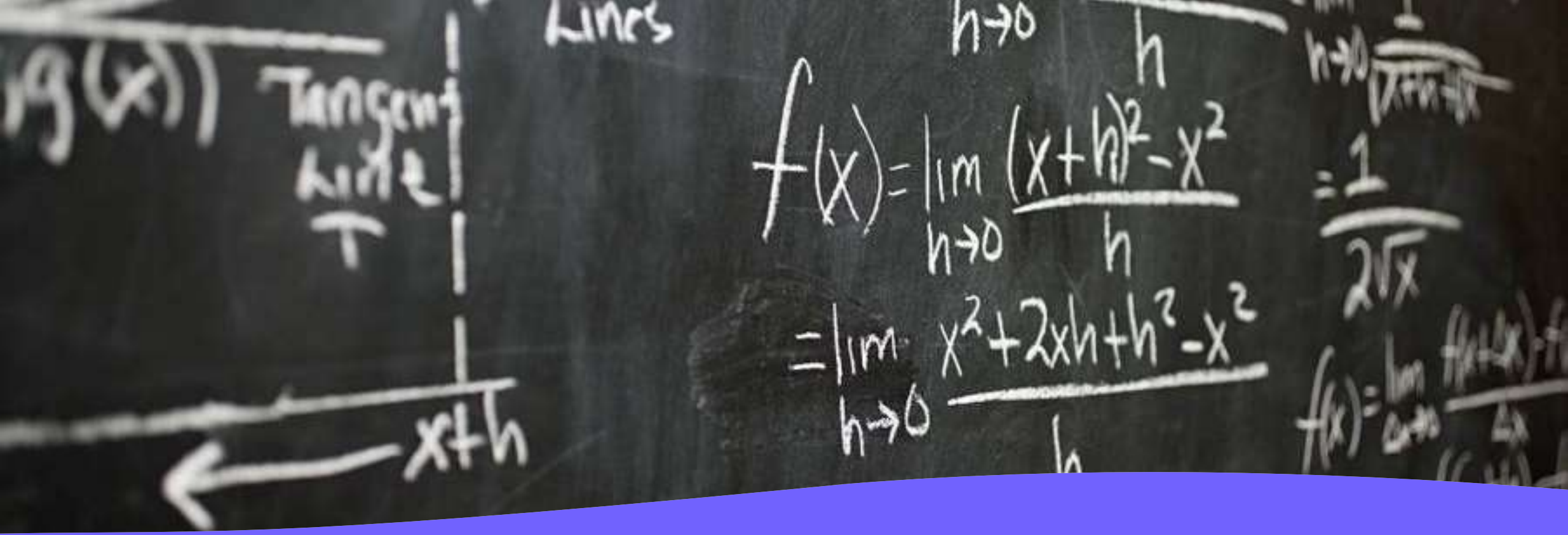


Intellectual Capital Economy & Creativity

Petros A. Simos

Innovation Manager,

i4byDesign Competence Center

Contents

Intellectual Capital Economy

Creative Economy (unique creations)

+

Knowledge Economy (science, engineering)

Common Characteristics:

- Intangible Assets based on Human Intellect
- Still Economy: “Purpose of business is to create a customer” (Peter Drucker)
- Role of Creativity

Economic Evolution

Agrarian Economy

(manual labour)

Industrial Economy

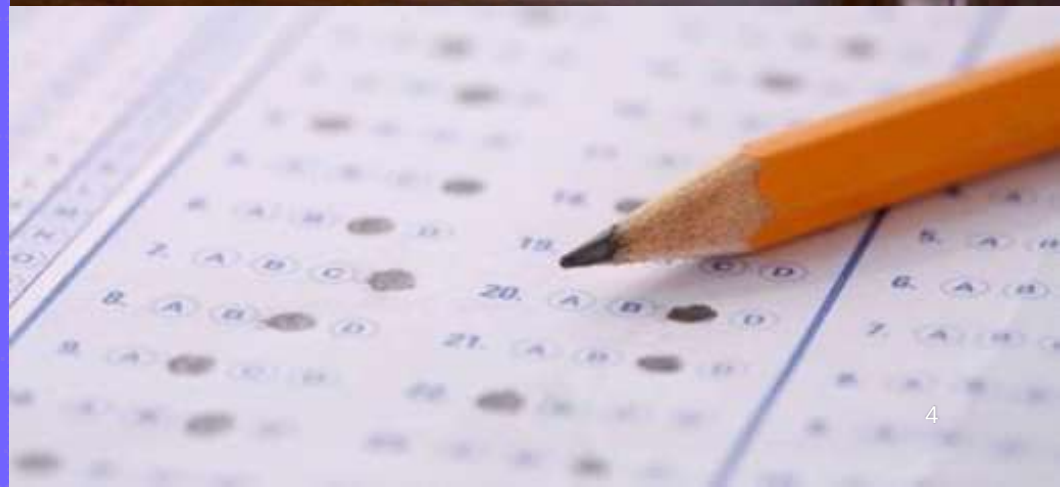
(human/machine – unskilled workers)

Service Economy

(emphasis on information)

Intellectual Capital Economy

(creativity, synthesis, philosophy of the field)



Creative Economy

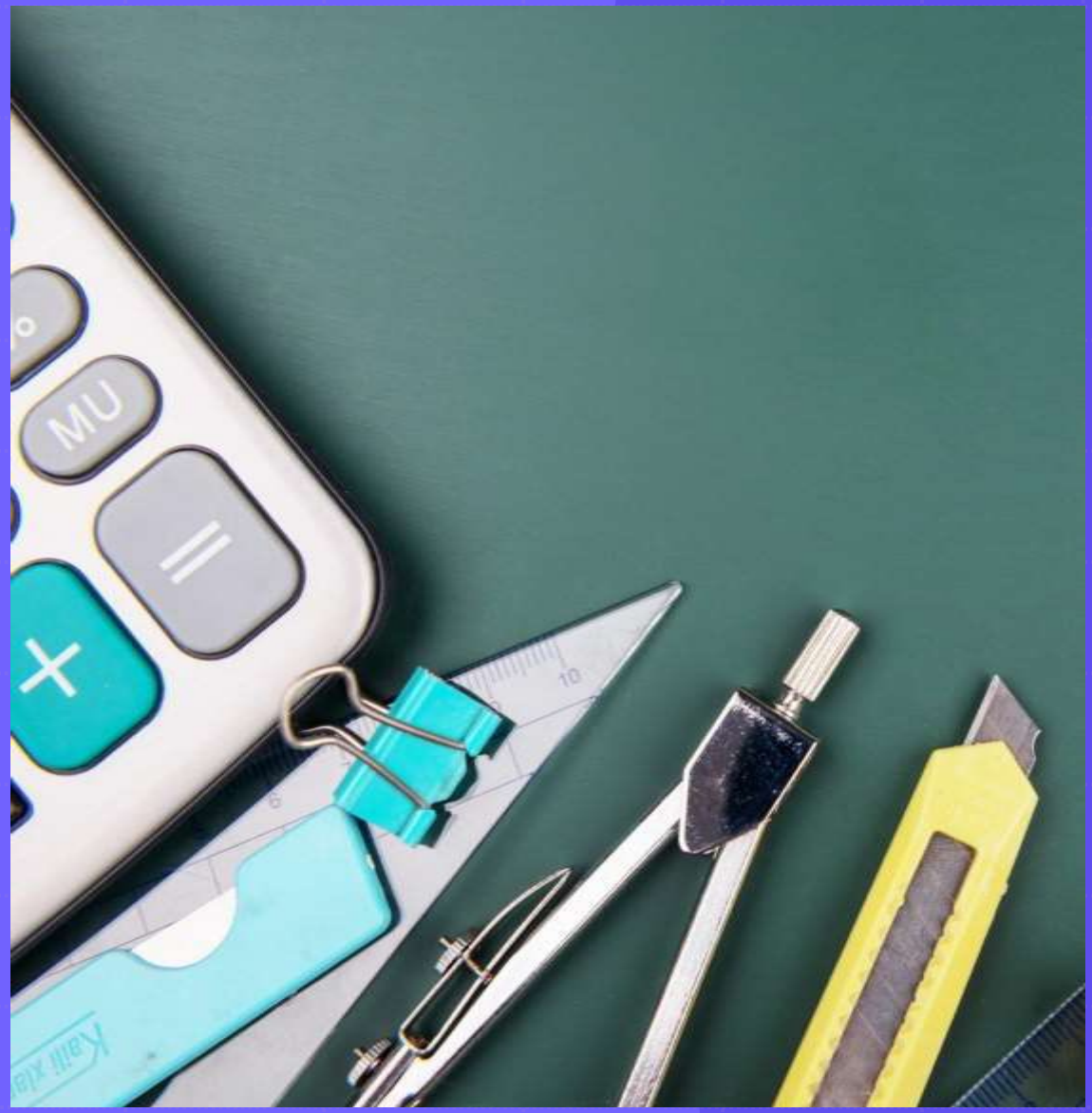
Ideas, Imagination, Cultural products…

Emphasis on **Unique Creative Content**

Knowledge Economy

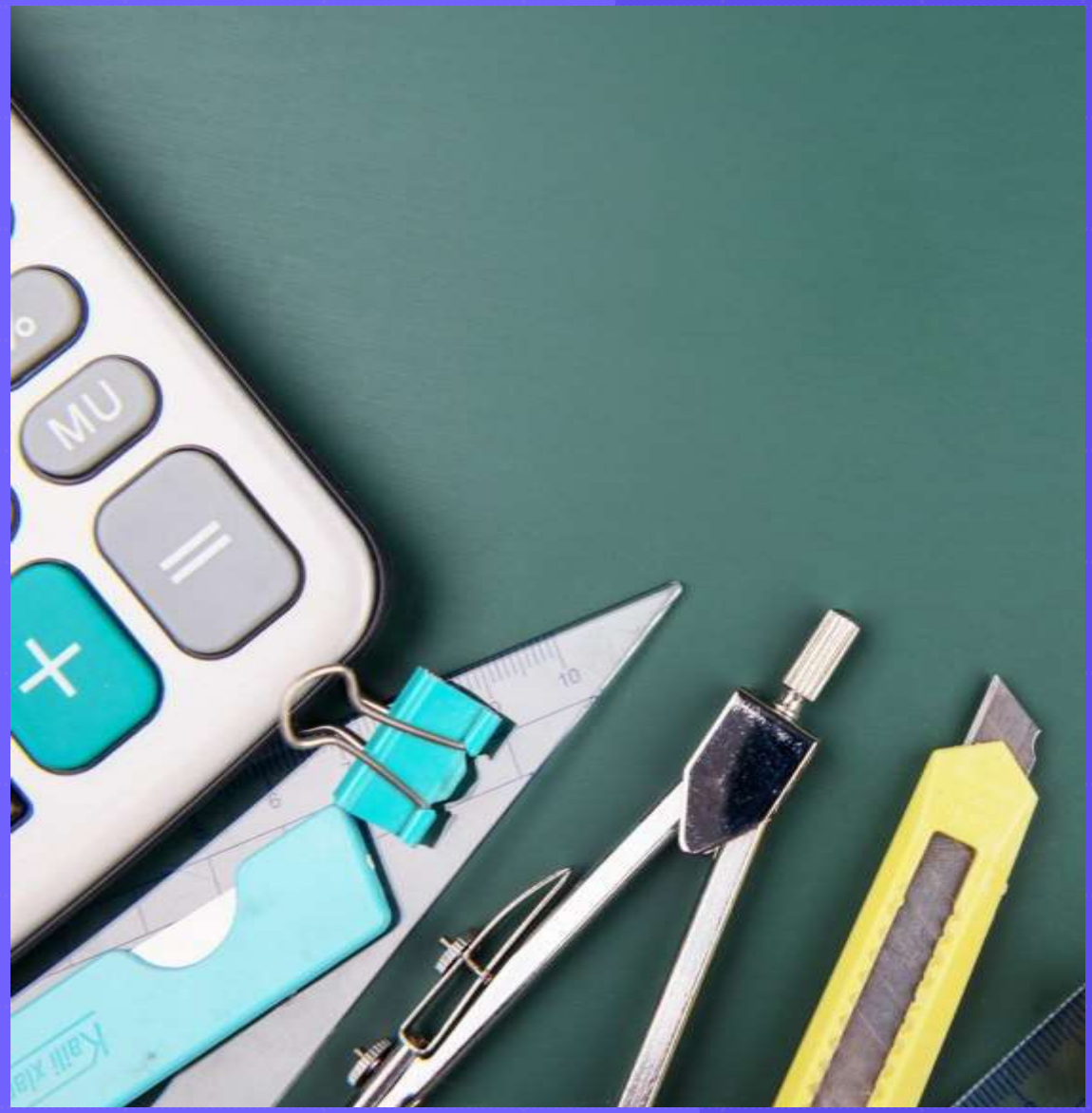
Research, Science, Innovation

Emphasis on **Education and Technology Products**



Britain: 13 Creative Industries

- Advertising
- Architecture
- Arts & Antiques
- Crafts
- Design
- Fashion
- Film
- Interactive Leisure Software
- Software
- Music
- Performing Arts
- Publishing
- TV & Radio



Importance of Creative Economy for Sustainability

Money Inequalities (gig economy – economically depressed areas to global audience)

Gender Inequalities (women creativity and flexible working environment)

Social Inequalities (access to information - courses/trainings and free tools)

Psychological Benefits (sense of creation)

Environmental Benefits (dematerialization & reusability)

Business Creativity

Examples

Cross-Domain Innovation

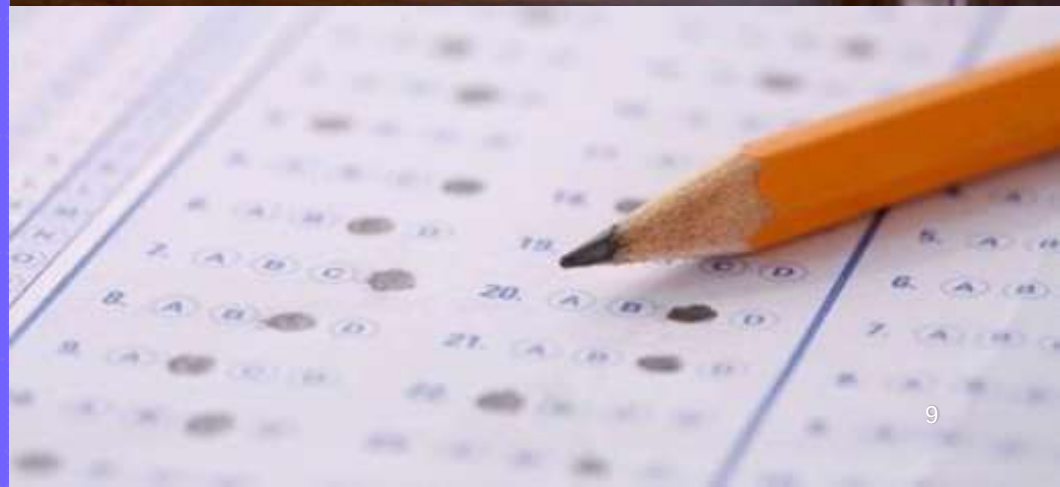
AirBnB (hospitality, sharing economy, tech)

Tesla (car, battery, software)

iPhone (telephone, computing, camera)

3D Printing/Health (materials, medicine, engineering)

Coursera/Udemy (pedagogy, gamification, multimedia)



SCAMPER

- Substitute
- Combine
- Adapt
- Modify
- Put to another use
- Eliminate
- Reverse

Substitute

Netflix

Replacing the traditional DVD rental model with a streaming service, making it more convenient for customers.

Uber

Substituting taxi services with a ride-sharing app, allowing users to book rides with their smartphones.

Combine

Apple

Integrating hardware, software, and services, such as the iPhone, iOS, and iTunes, to create a seamless user experience.

Amazon

Merging online shopping with cloud computing services, creating a diverse range of products and services under one company.

Adapt

Coca-Cola

Adapting to changing consumer preferences by introducing healthier options such as Coca-Cola Zero and Diet Coke.

McDonald’s

Adapting to growing health-consciousness by adding healthier options like salads and fruit to their menu.

Modify

Tesla

Modifying traditional automobiles by developing electric vehicles, revolutionizing the automotive industry.

AirBnB

Modifying the hotel and vacation rental industry by allowing homeowners to rent out their properties to travelers.

Put to another use

Lego

Expanding beyond toys by creating movies, video games, and theme parks based on their iconic building blocks.

Listerine

Originally developed as a surgical antiseptic, it is now used primarily as a mouthwash.

Eliminate

Dropbox

Removing the need for physical storage devices by providing cloud-based file storage and sharing solutions.

Online Banking

Reducing the need for physical bank branches by offering banking services through web and mobile applications.

Reverse

IKEA

Reversing the traditional retail model by offering flat-pack furniture, which reduces transportation and storage costs.

Kickstarter

Reversing the traditional investment model by using crowdfunding to support creative projects, empowering creators to bring their ideas to life.

Personal Creativity

Personal Creativity

Who am I?

Try to answer this QUESTION:

“In which two fields am I better than peers?”

I write for myself	Ask 5 friends/relatives	Ask each one (of friends) 5 whys
• Before asking others, I concentrate on my journal and try to answer: In which two fields do I believe that I am better than my peers?	• I ask them open questions to explain the reasons, to remember stories. That's how we understand ourself.	• Why do you say this? Could you please explain further? Did that really impress you so much? Could you say an example of this situation? What factors led you to that conclusion? How did you arrive at this viewpoint? • YES, FIVE TIMES WHY!!!

In which two fields I am better than peers?

Brainstorming

Aim for Quantity over Quality

Write down 20 ways to solve this problem.

Organize them into categories

7h – 9h daily sleep

Book: Why we sleep by Matthew Walker

Book: The magic of sleep thinking by Eric Maisel

Expression: “Sleep on this”

The Best Cognitive Approach: Journaling

Ask only tough questions:

What went well? What went bad? What do I change?

Why do I want this? How could I do it simpler? Which are the two priorities?

How can this urgent/short-term goal can be combined with long term goals?

Questions with HOW & WHAT -> To solve the problem.

Thank you

Petros A. Simos

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