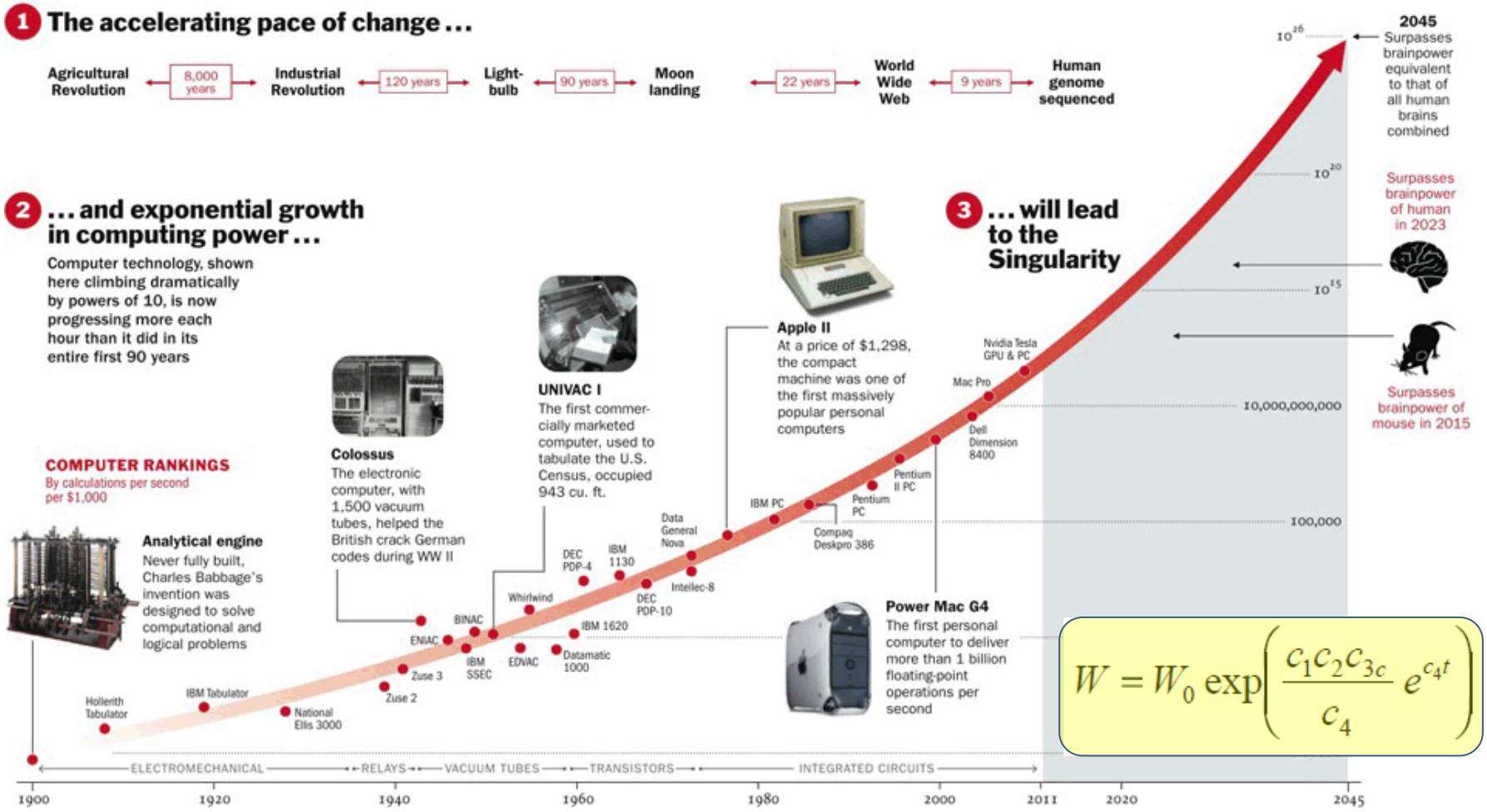
Machinery 4.0 :

Toward A Quantum Jump of Korea Mfg. Industry

KIMM 한국기계연구원
KOREA INSTITUTE OF MACHINERY & MATERIALS

Accelerating Pace of Change



$$W = W_0 \exp\left(\frac{c_1 c_2 c_{3c}}{c_4} e^{c_4 t}\right)$$

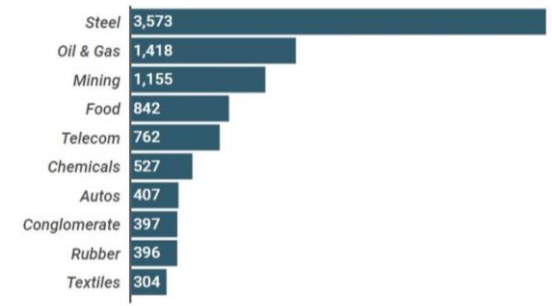
※ 2045: The Year Man Becomes Immortal, TIME, 2011

※ The Singularity Is Near, Ray Kuzweil

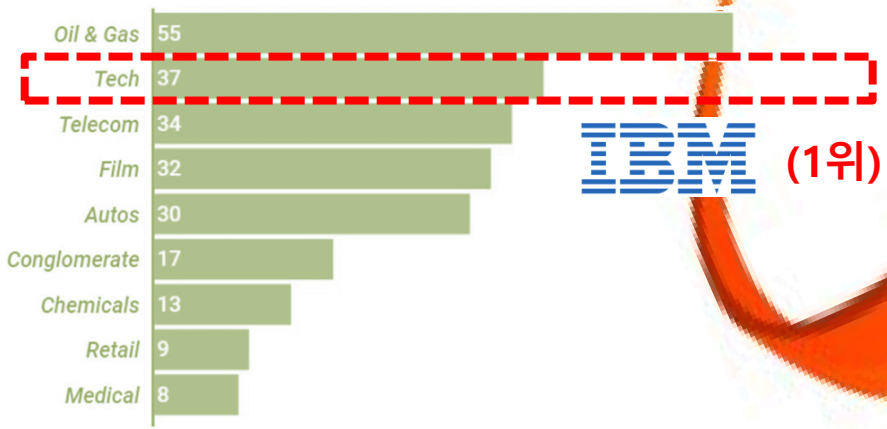
Emerging High Tech Industries

America's Top Companies (1917-2017)

• **1917** (Asset Value : Mil. $)

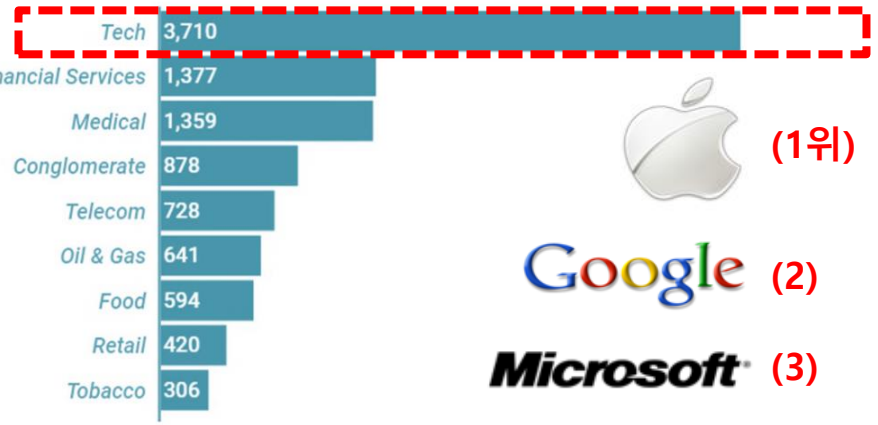


• **1967** (Asset Value : Bil. $)



IBM (1위)

• **2017** (Asset Value : Bil. $)



(1위)

Google (2)

Microsoft (3)

amazon (4)

facebook (6)

ORACLE (18)

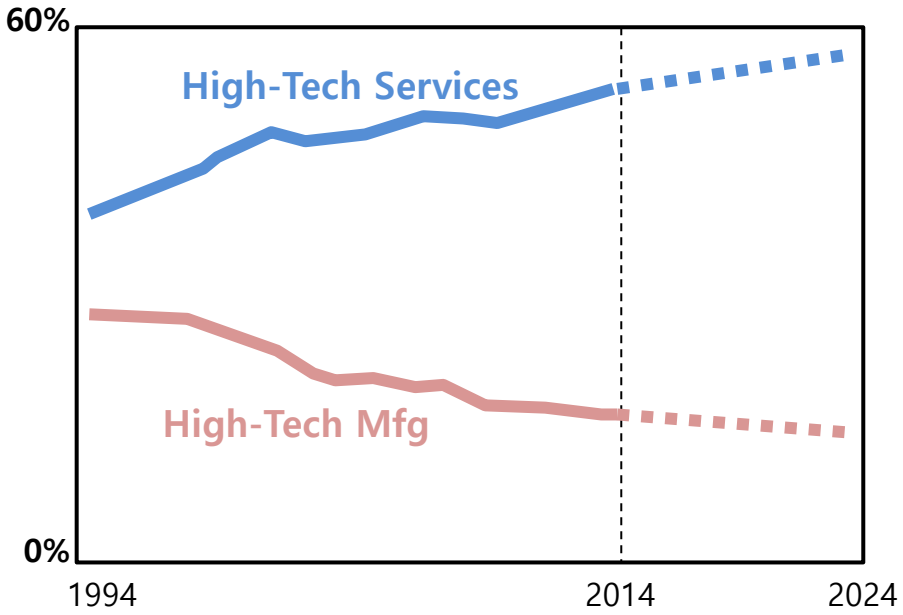
intel (29)

IBM (33)

※ Forbes.com (2017.9.19.)

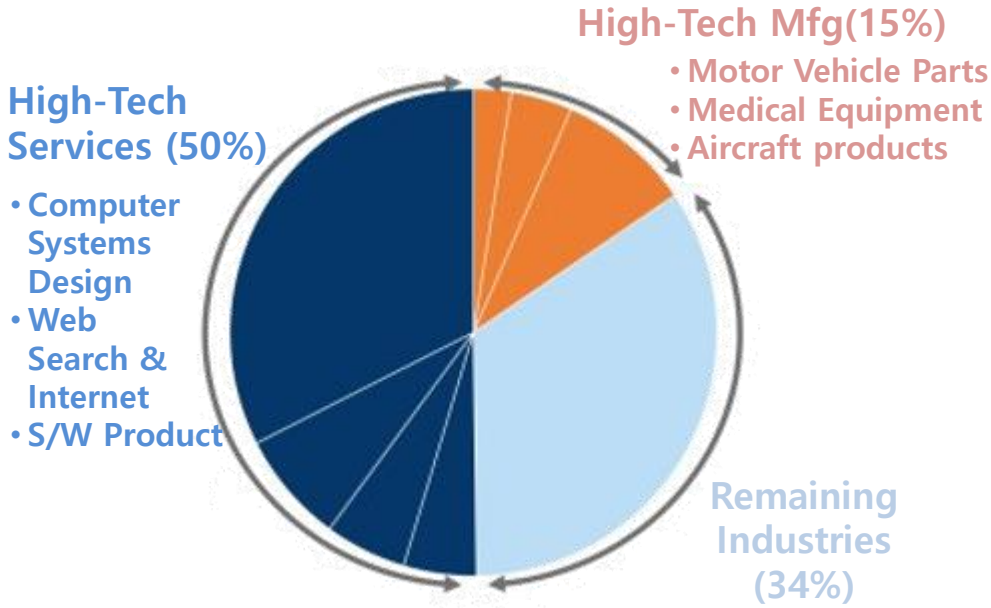
Manufacturing vs. Services in US

Annual Share of high-tech employment



Advanced industries sector job creation

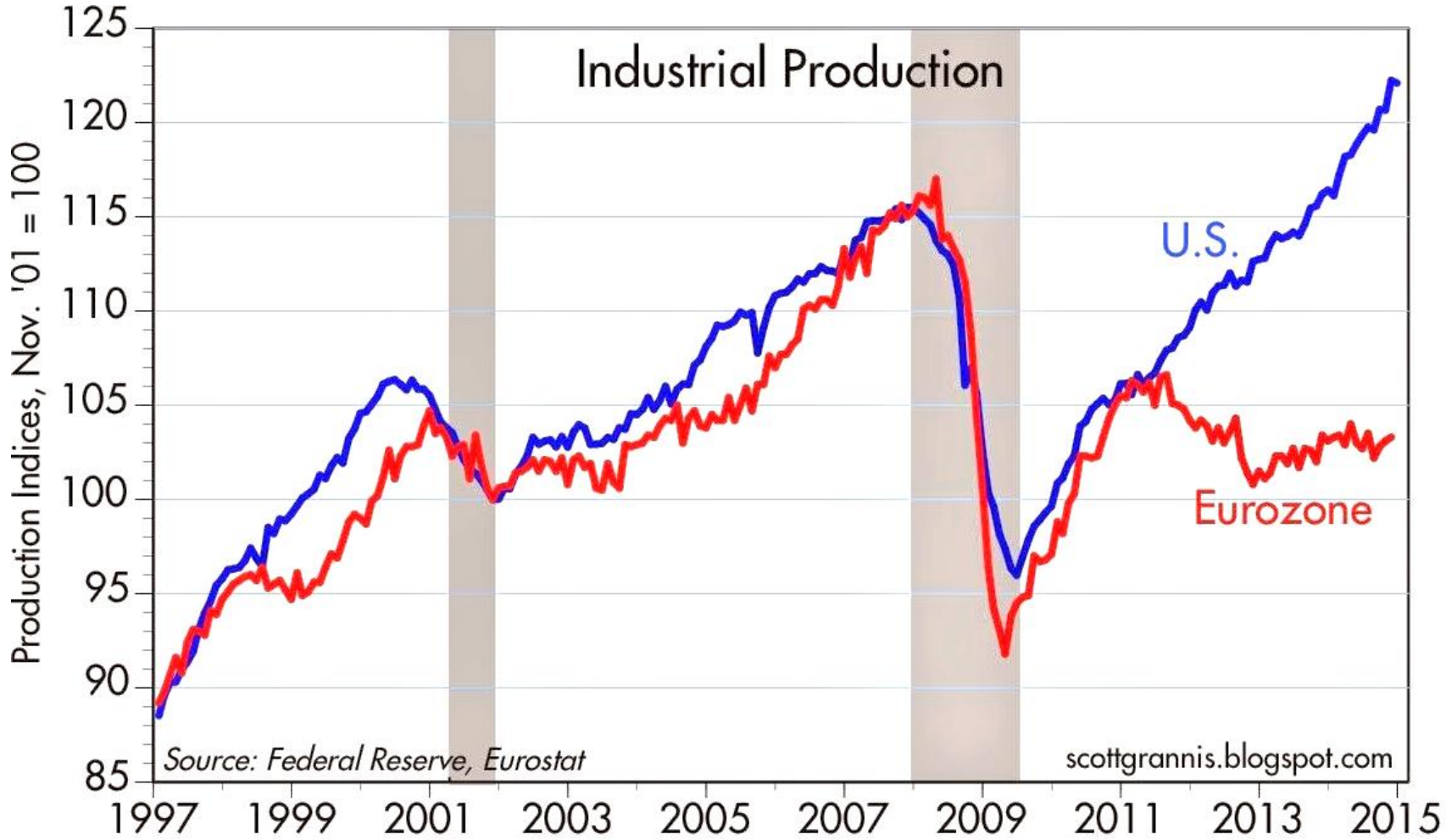
(2013-2015)



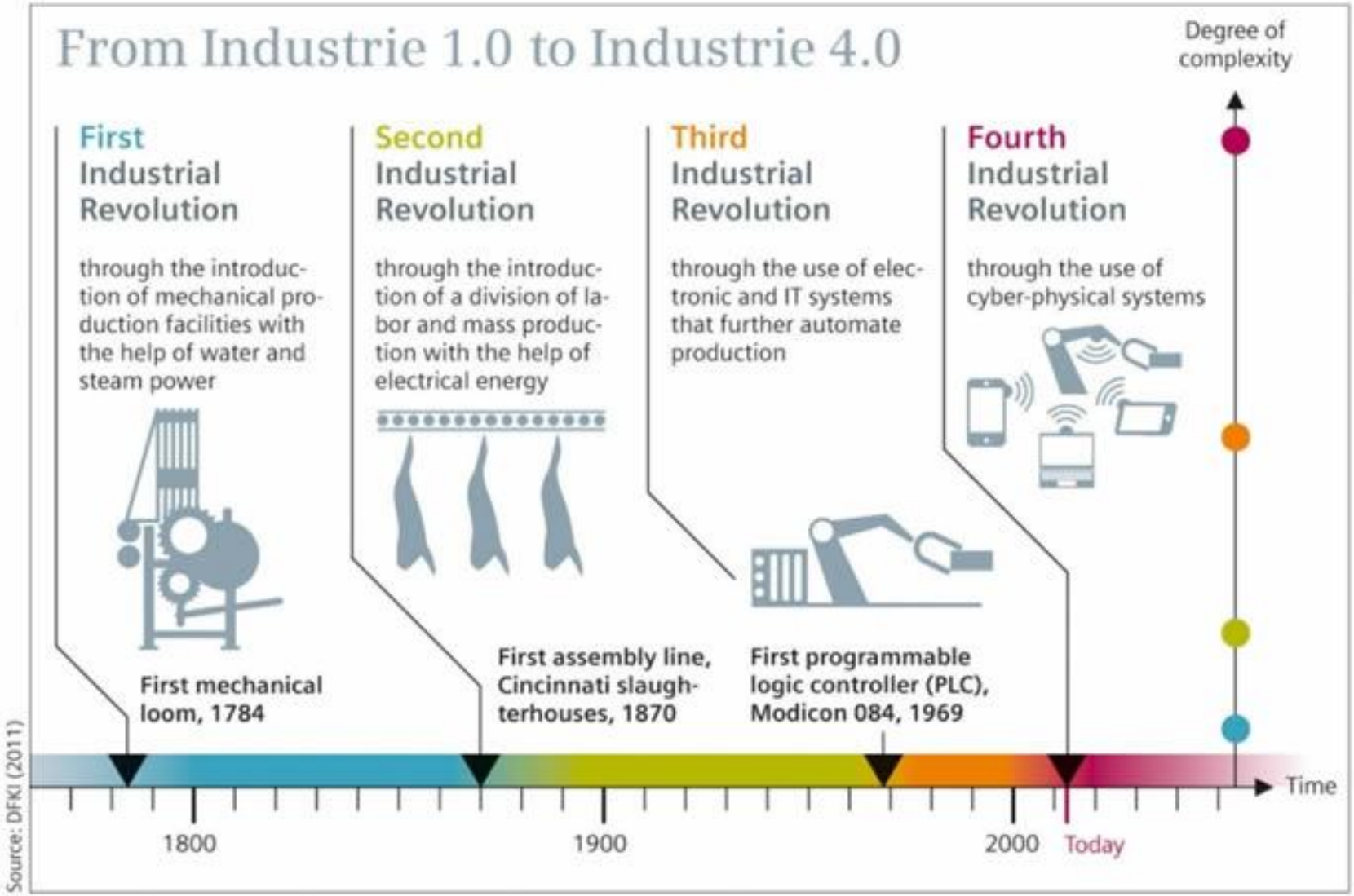
※ U.S. Bureau of Labor Statistics

※ Brookings's analysis of Moody's Analytics estimates

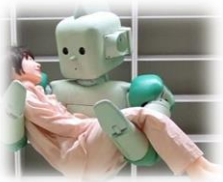
Industrial Production of US vs. EU

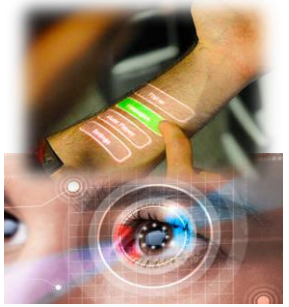


Industry 4.0



Glancing at Tipping Points





2018 – Storage for All

2021 – Robot and Services

2022
- The Internet of and for Things
- Wearable Internet
- 3D Printing and Manufacturing

2023
- Implantable Technologies
- Big Data for Decisions
- Vision as the New Interface
- Our Digital Presence
- Governments and the Blockchain
- A Supercomputer in Your Pocket

2024
- Ubiquitous Computing
- 3D Printing and Human Health
- The Connected Home

2025
- 3D Printing and Consumer Products
- AI and White-Collar Jobs
- The Sharing Economy

2026
- Driverless Cars
- AI and Decision-Making
- Smart Cities

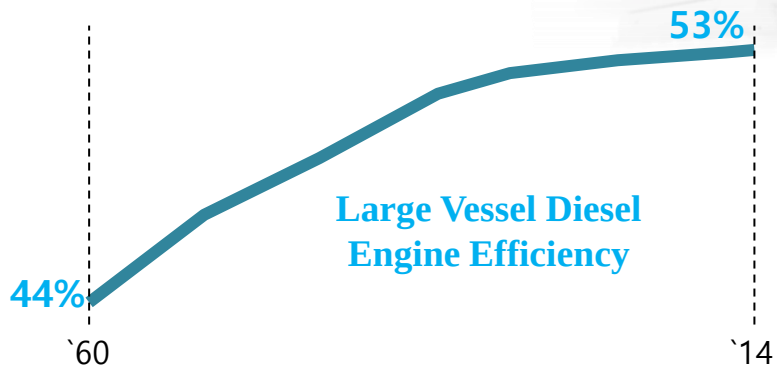
2027
- Bitcoin and the Blockchain

Source) WEF 2016 : Mastering the Fourth Industrial Revolution

Source) Deep shift, WEF(2015.9)

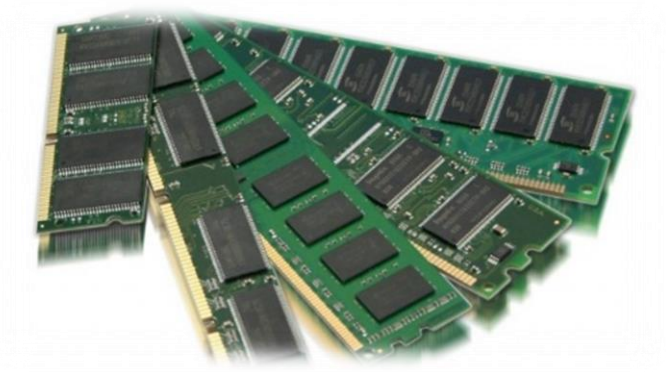
Machinery Tech. Stagnation

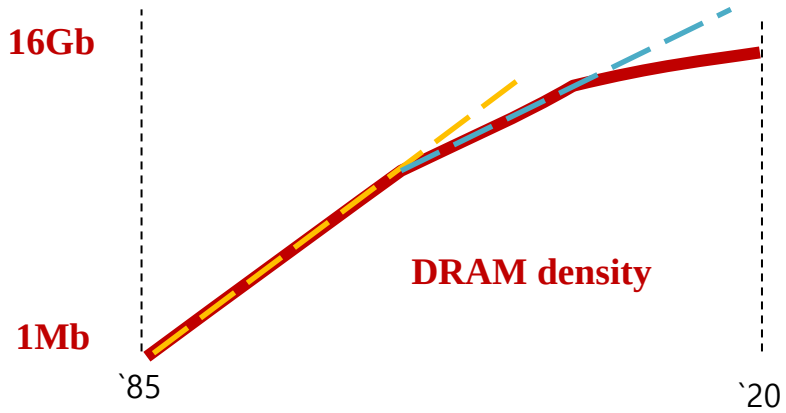
Marine engine fuel efficiency development



(source: energy efficiency centre)

Semiconductor fabrication





(source: flash memory summit 2015)

Machinery Tech. Stagnation

Fuel consumption reduction in cars

43%

43% Reduction
during 15 years
(‘75~’90)

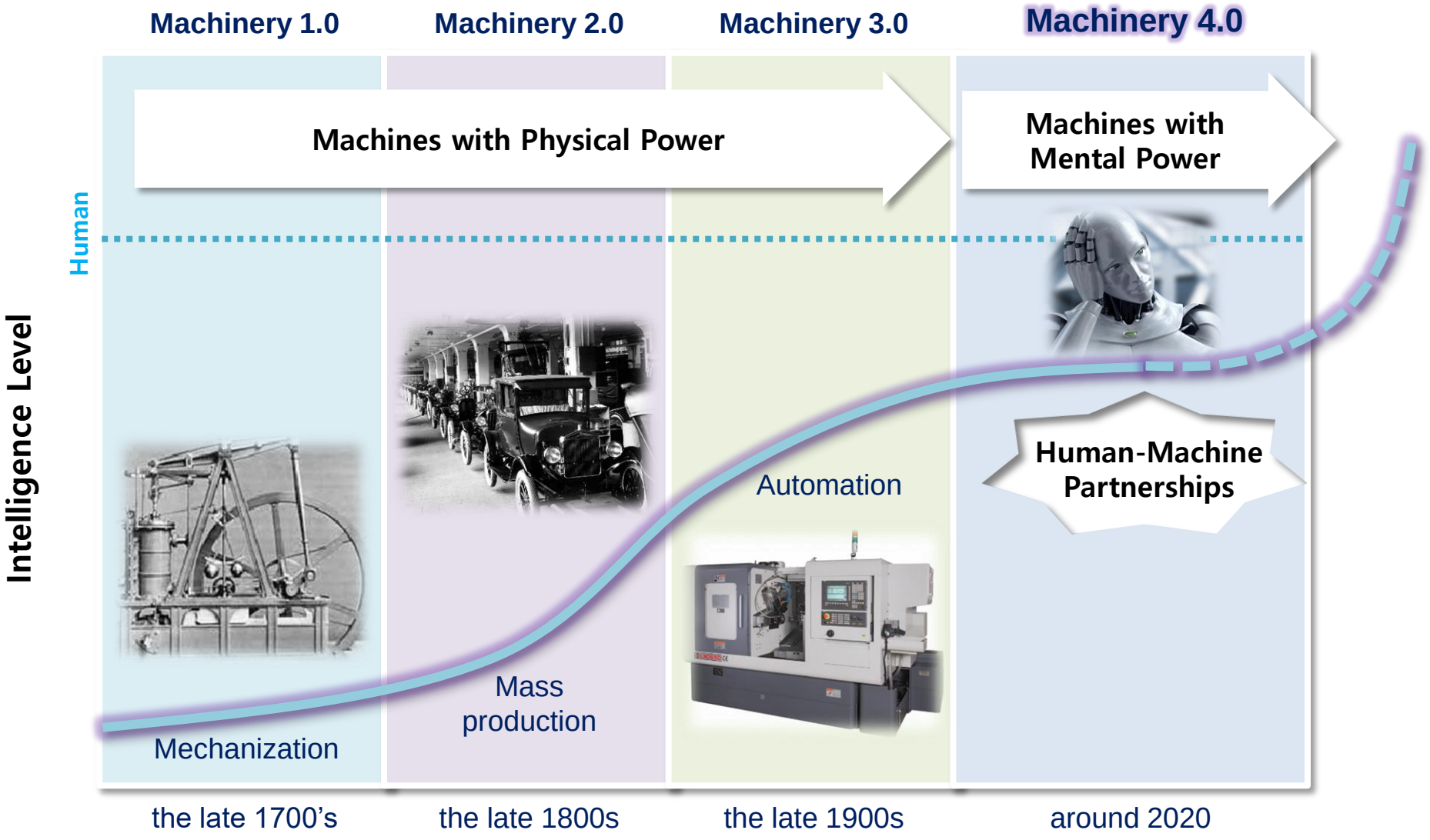
15%
(CAGR 0.8%)

15% Reduction
during 20 years
(‘90~’09)

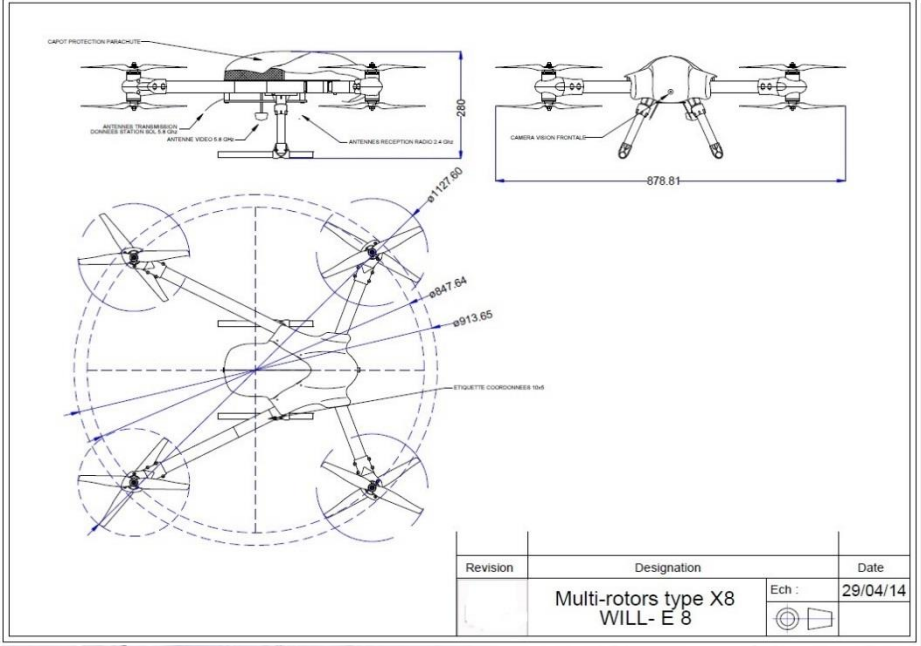
(source: D. MacKenzie et. al., Applied energy, 2015)

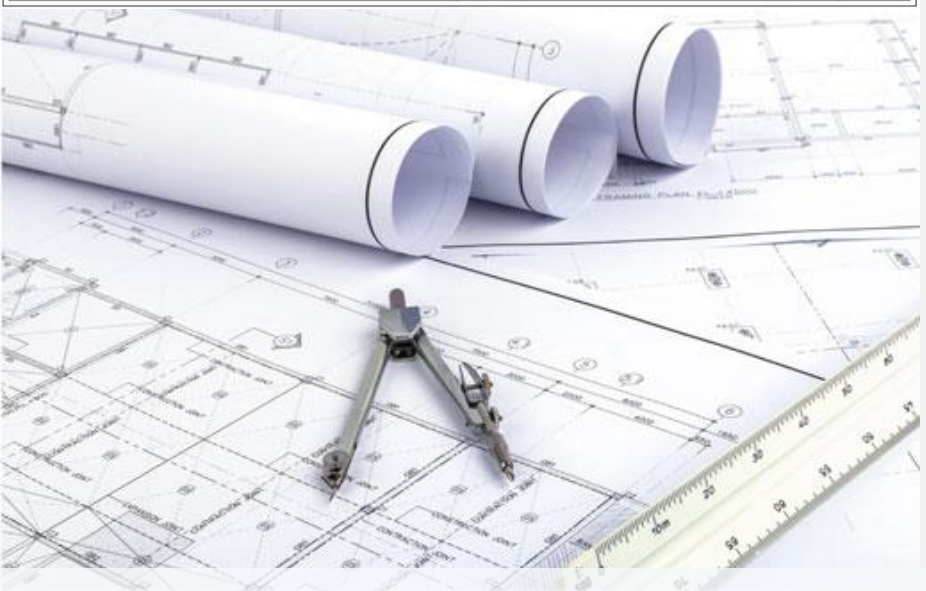
?

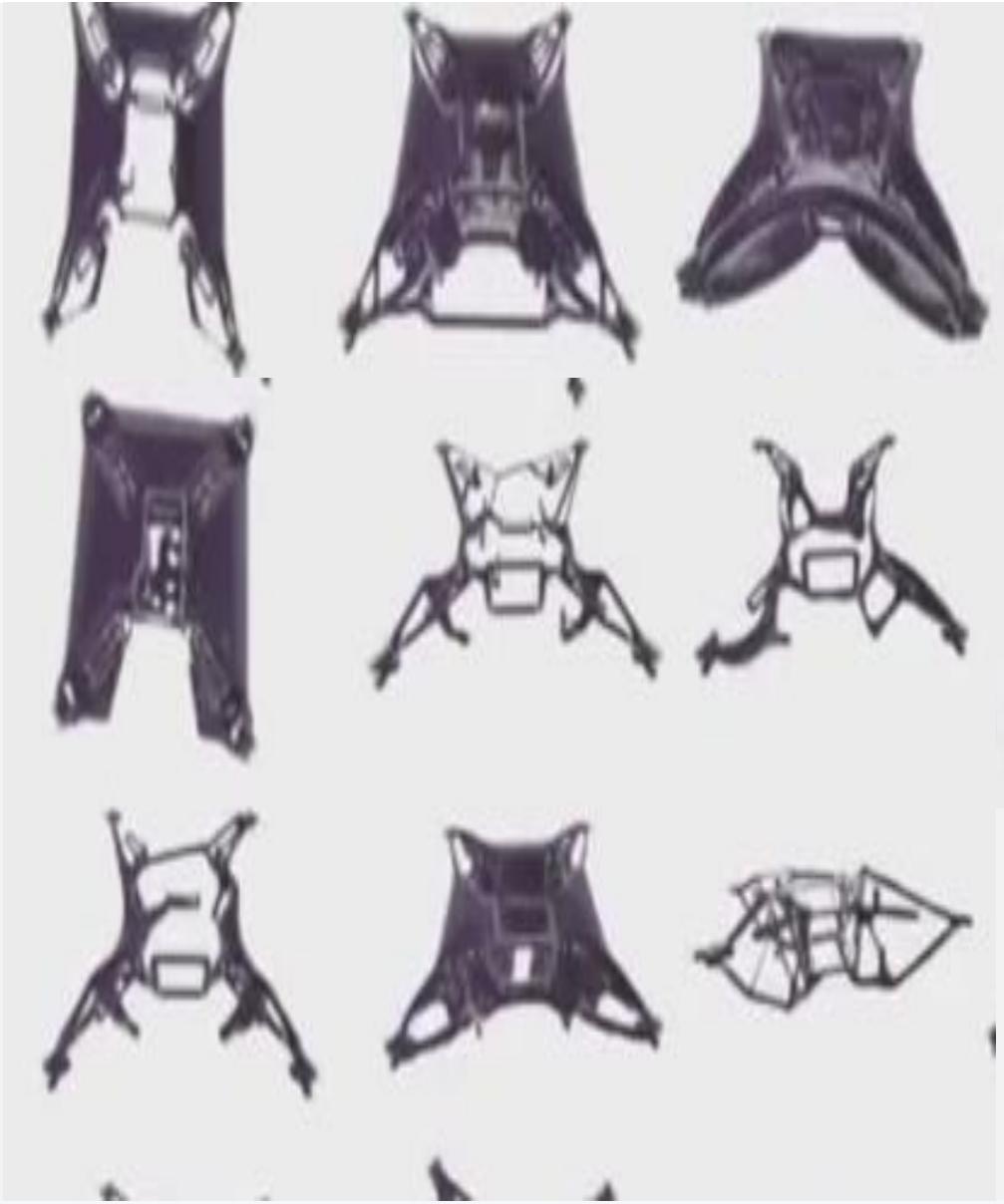
Machinery Paradigm Shift



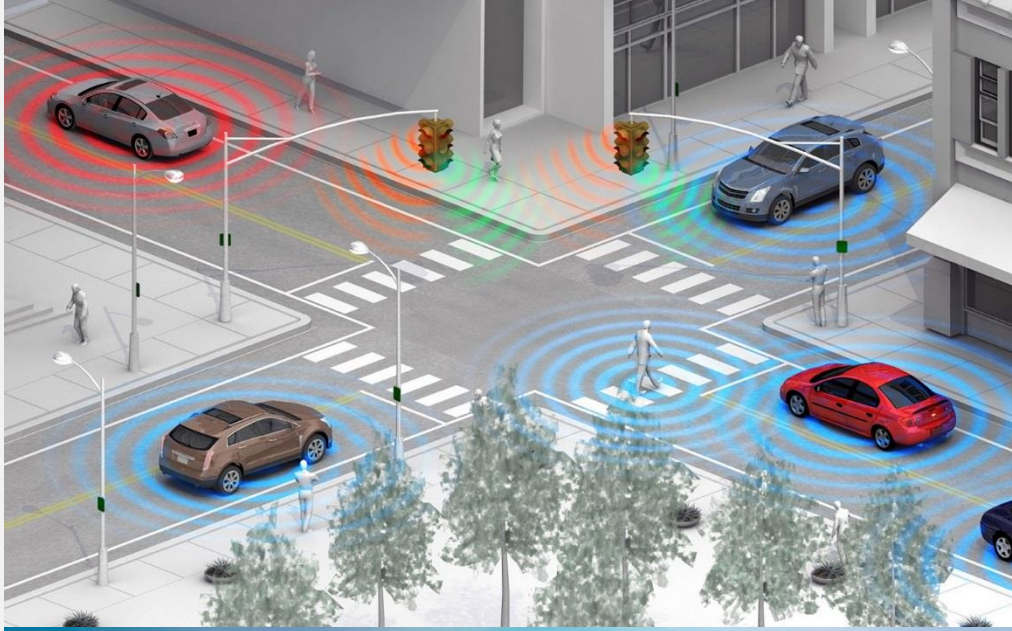
Unstructured → Structured





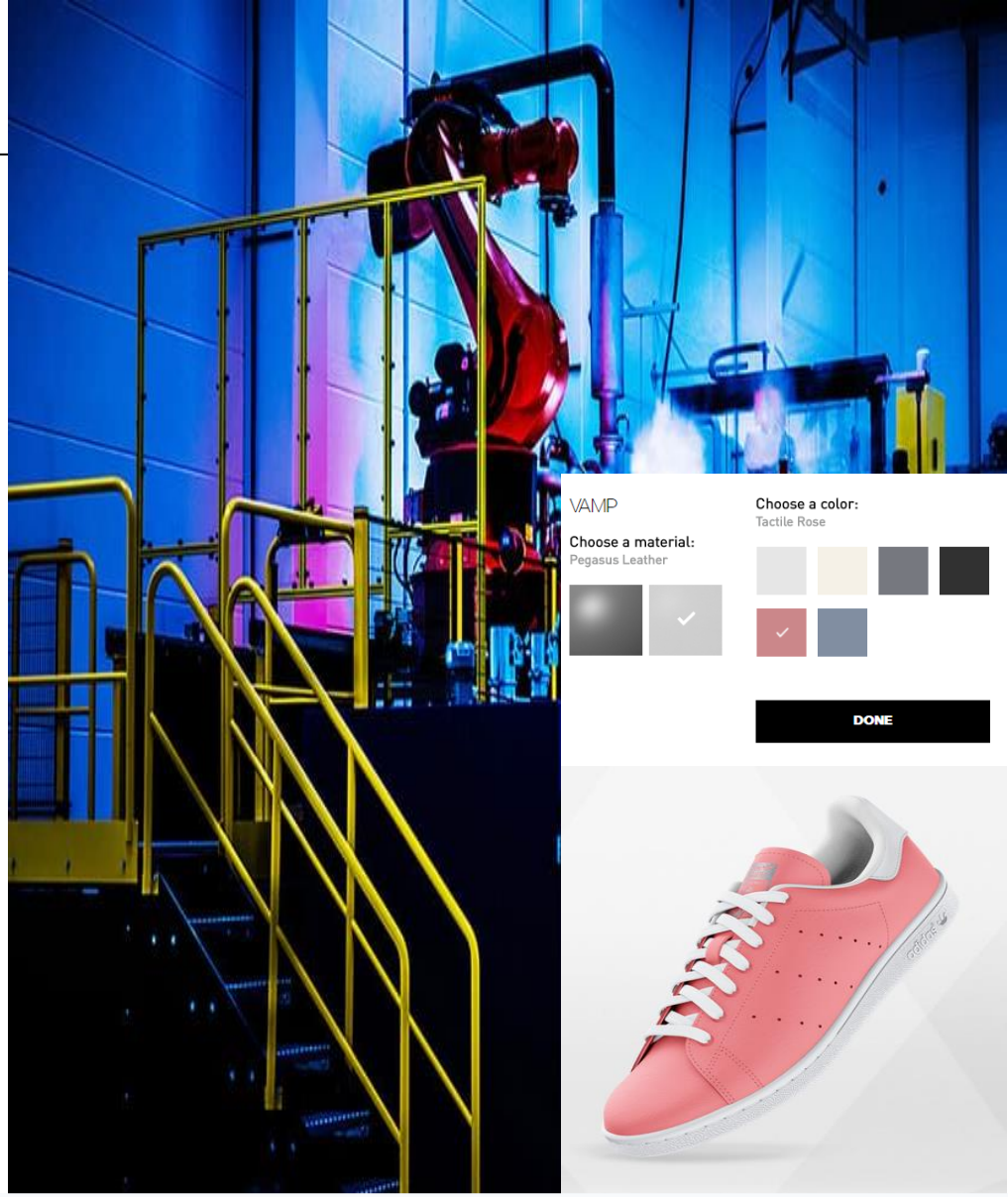


Deductive → Intuitive



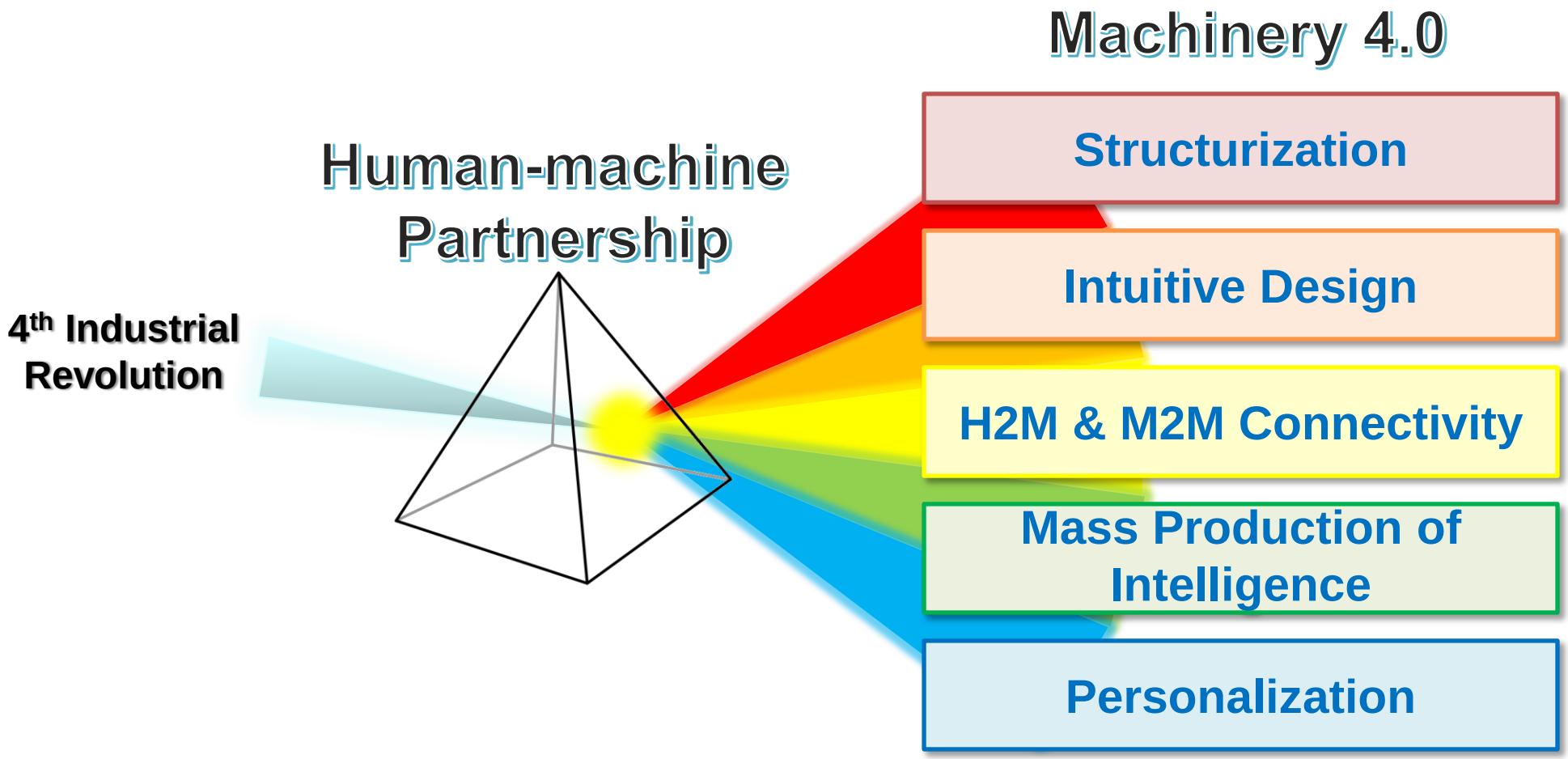
Isolated → Connected

Mass production of Intelligence

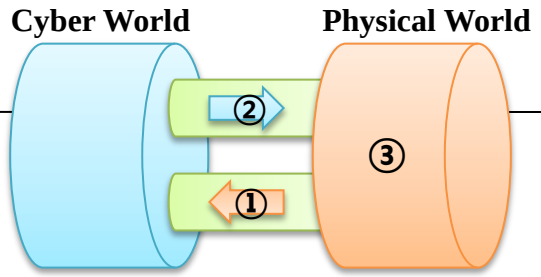


Personalization

Machinery 4.0 / Philosophy



Machinery 4.0 / Strategic Directions



1 Mass Intelli-gence.

Mass production of intelligence

- Digital transformation of expert knowledge & machinery O&M data
- Cloud intelligence transfer to edge machines for human-machine collaborations

2 Platform

Machinery service platform developments based on AI

- Autonomous mfg. platforms for design, processing, O&M, etc.
- Autonomous working platforms (recognition, decision, cooperation, etc.)

3 Disruptive

Disruptive technology exploration to face challenges in machinery industry

- (e.g.) Manufacturing without molding process / Frameless machines
  Robots with artificial muscles / Super high speed transportation systems


KIMM's R&D activities
Present and Future

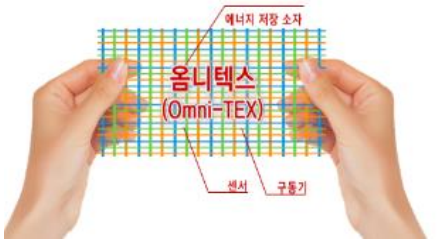
We are focusing on…

AI-based Design Platform

CPS-based Service Platform

Innovative Mfg. Technology

Fusion Tech. among Foreign Industries



"Securing future promising technologies to accelerate key industries and to cope with changes in job opportunities"

Smart Design Platform

Development of smart design platform utilizing machine simulation technology

- S/W platform(From Design to CAE) of 9 core mechanical module and components (‘16~’21)

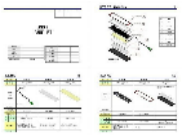
  - Gear trains, Gas turbine burners, Micro dust collectors, Bearings, Injection nozzles, etc.

Intuitive Machine Design Platform('18~)

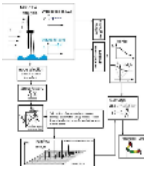
Demand-based intuitive design from non-professional designer

- Core tech: Associated industrial design data, expert knowledge, CAE verification tools

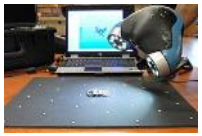
Handbook, catalog



Industry BOM DB



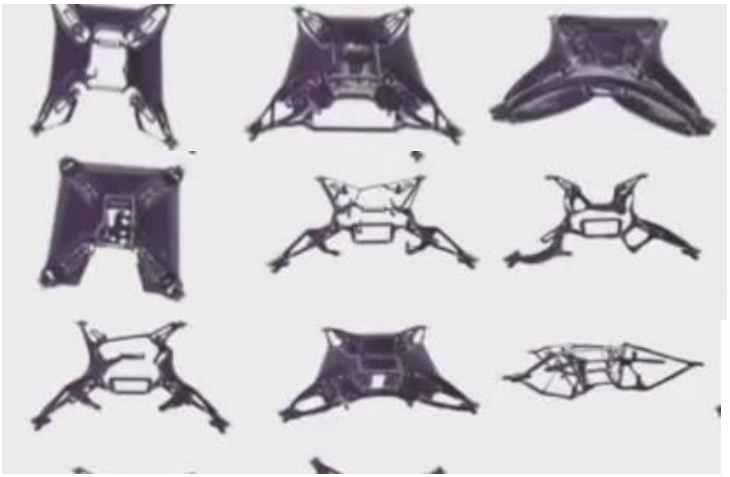
Reliability/ O&M data



Real 3D object data

e.g.) Drone body design

AI-based intuitive design: Propose multiple design drafts → selection



Bigdata tech. AI-based design tech. Post-processing data/re-learning

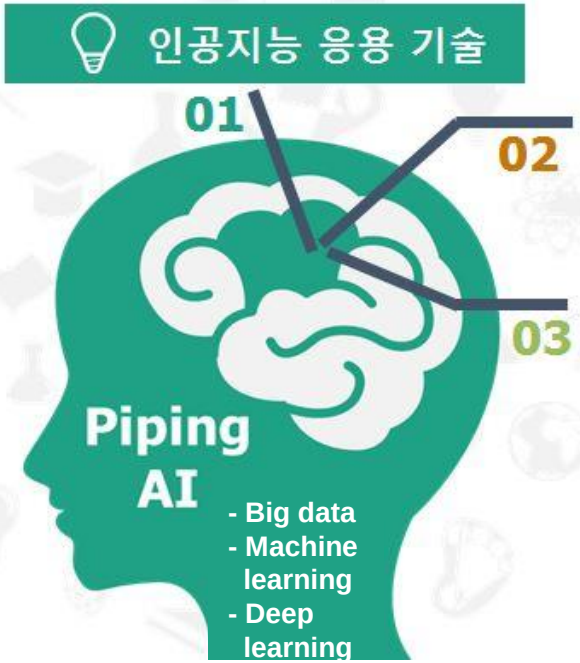
Expert knowledge System (self-learning)

AI based Plant Management System

Service Platform

AI based monitoring, predictive diagnosis and damage management technology

AI based predictive diagnosis & damage management



Predictive diagnosis

- Special purpose pump system
- Failure by internal factors
- Fault high-risk system

Damage management

- Ship pipeline system
- Failure by external factors
- Fast recovery system

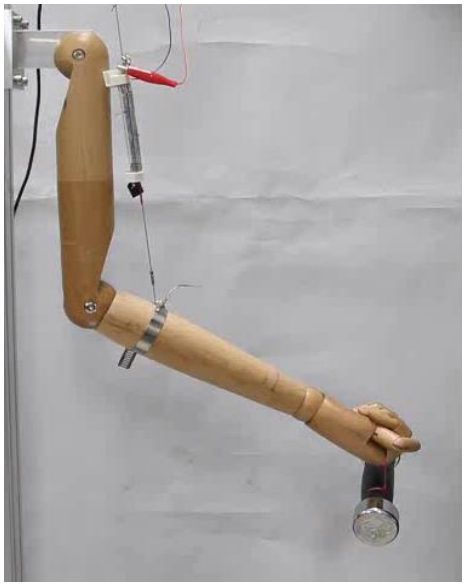
Industrial Dual Arm Robot

Cooperative robot in assembly line with human worker

- AMIRO : Dual arm robots capable of packaging/assembling in cell production process
- Human-friendly Collaborative Robot in Mfg sites

- AMIRO -

Motor, gear → human like muscle



- Artificial muscle actuator -

Mobile Machining System

Environment adaptable machining platform developments

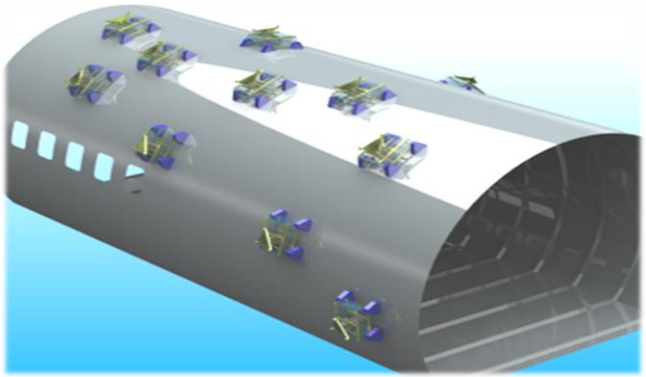
- Mobile drilling/milling machine based on diverse moving mechanisms
- Free form workpiece machining module with less than100 ㎛ precision accuracy

Concept of mobile machining

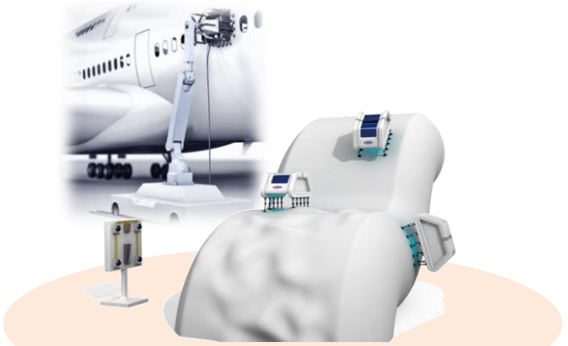
Workpiece on the machine

Frameless machine tool

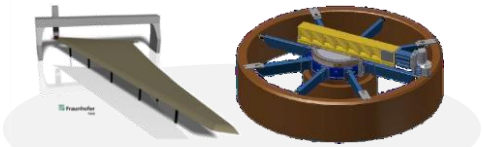
Machine on the workpiece



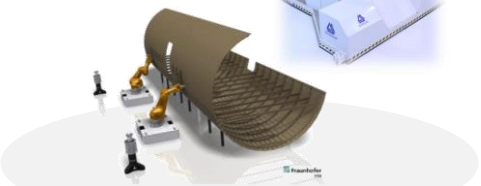
Mobile Machine Platform Topology



Crawler type
(workpiece is machine support structure)



Car wash type
(using gantry structure)



Cherry picker type
(mounted over mobile platform)

Autonomous Working Robots/Machines

Autonomous working machines in unstructured environments

- Autonomous operation based on Artificial Intelligence
- Human-machine collaboration, machine-machine collaboration

Autonomous & Collaboration Robots/Machines

<SME Mfg>

<with obstacle>

<Tool usage>

<Collaboration>

Rough terrain

cognition& control

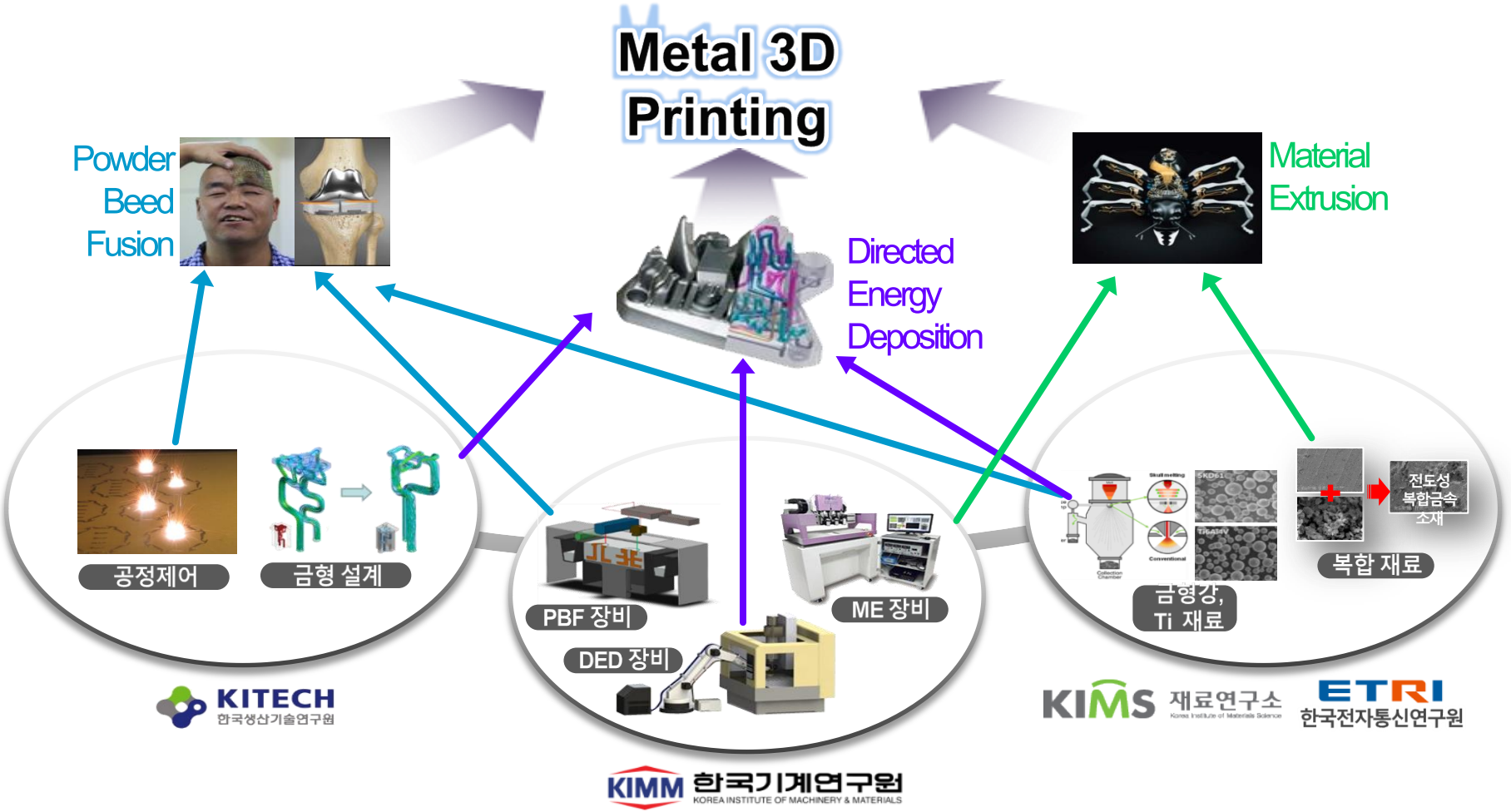
HRI

Tele-operation

Metal 3D Printing

M3P(Metal 3D Printing) technology developments (‘16~’18, 26 Bil. KRW)

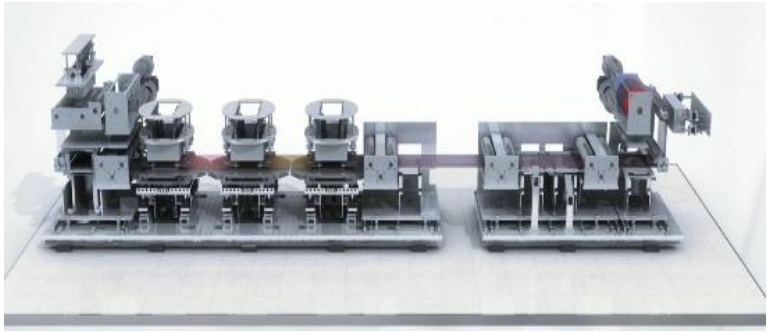
- Commercialization of Metal 3D Printing (PBF, DED, ME) equipment with high industry demands



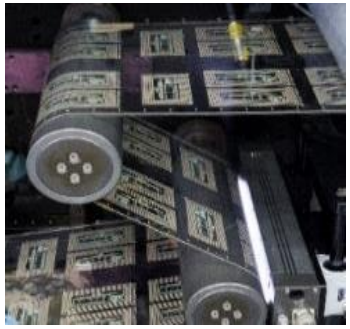
Flexible Electronic Device Mfg. Tech.

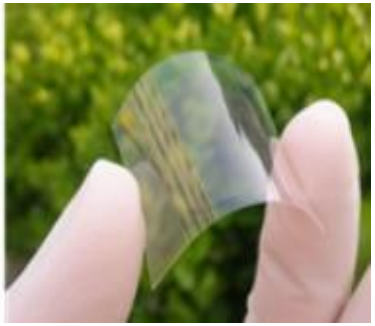
Roll-to-Roll processing and Micro LED Mfg technology

R2R Hybrid flexible device



- Vacuum metalizing equipment -





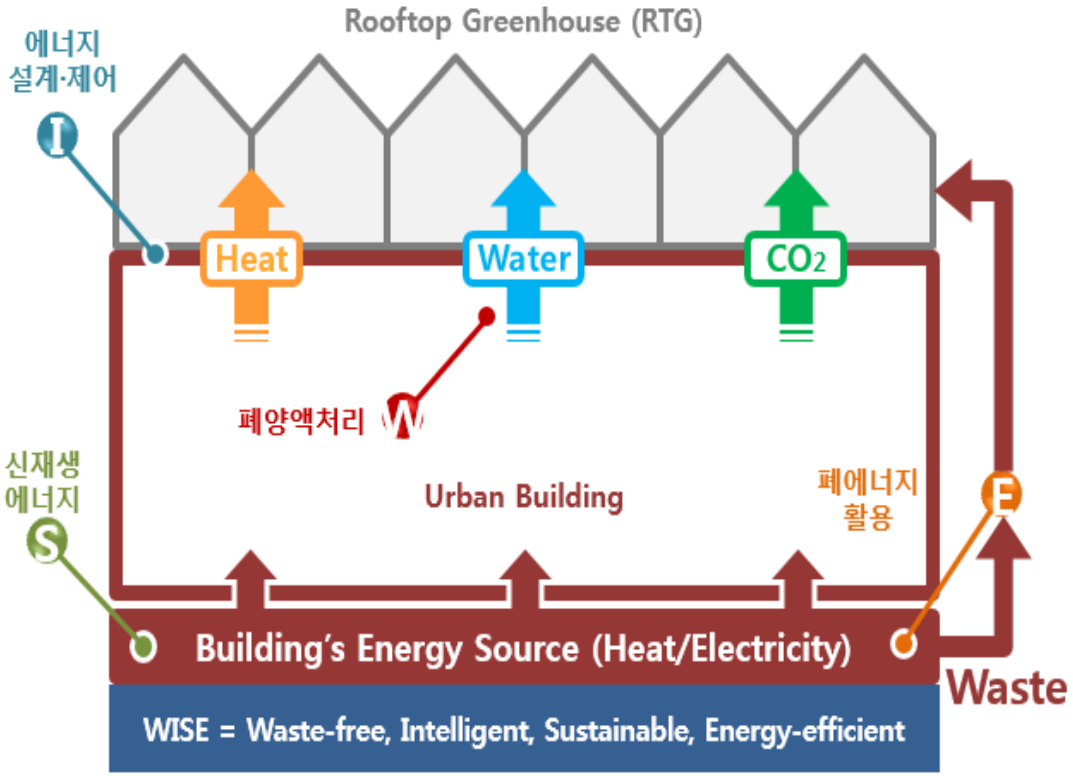
- Transparent electrode printing technology -

Micro LED Mfg Tech.

AI based Wise Farm Building

Reduction of urban agriculture energy & utilization of building waste energy

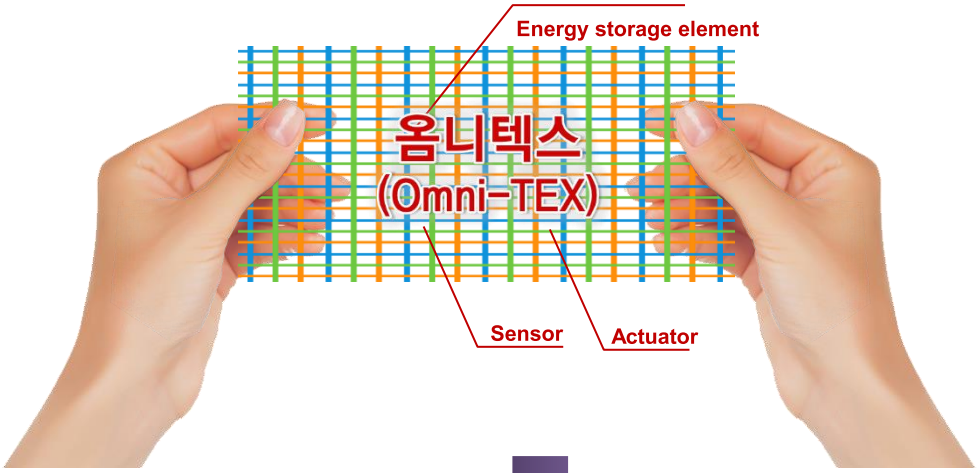
- Urban agriculture : energy reduction + Urban agriculture expansion
- Building energy : energy reduction + Distributed power generation expansion



Nano-based Omni-TEX Technology

Next generation nano-micro element platform development

- Breakthrough of textile fabrication technology through fabric type stretchable nano-micro process
- Core material & process technology applied to smart wearable, advanced sensors, immersive actuation interfac



Energy
- Fabric type capacitor, solar cell, friction power generation

Exterior material
- Antifoul/waterproof stretchable material

Optical functionality
- Fabric type high functional luminous body


INNOVATION ENGINE
FOR TOMORROW

감사합니다 !

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KOREA INSTITUTE OF MACHINERY & MATERIALS