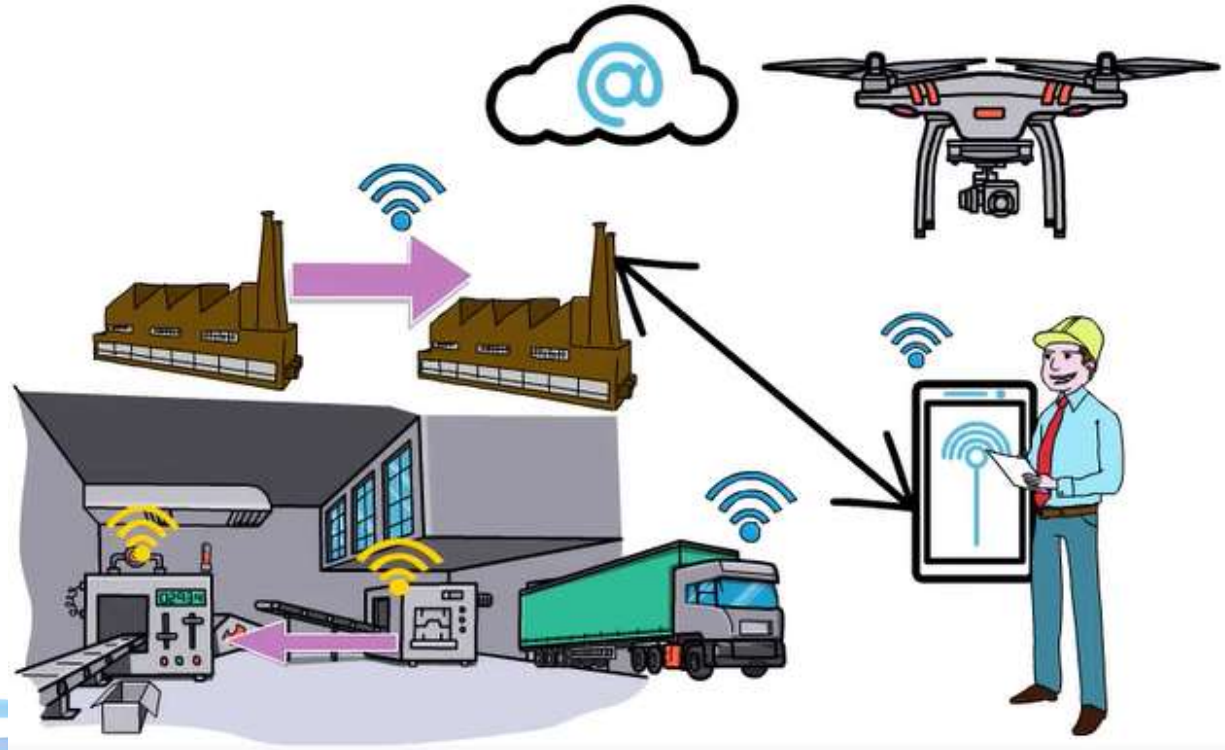
Thai-German Institute
สถาบันไทย-เยอรมัน

กระทรวงอุตสาหกรรม
Ministry of Industry

กรอบแนวคิด Industry 4.0 for Smart SME

กรมโรงงานอุตสาหกรรม
DEPARTMENT OF INDUSTRIAL WORKS

Total Smart Solutions for Your Success



นายสิริวัฒน์ ไวยนิตย์
ศูนย์เทคโนโลยีการผลิตอัตโนมัติและหุ่นยนต์
สถาบันไทย-เยอรมัน

Industry 4.0 is one of the most frequently discussed topics among practitioners and academics today

Agenda

- Why Automation and I4.0 benefit for Thailand?
- Industry 4.0 Revolution
- What is Industry 4.0 and Vision?
- Benefit of Industry 4.0
- Industry 4.0 framework
- Key technology support I4.0

Why Automation and I4.0 in Thailand

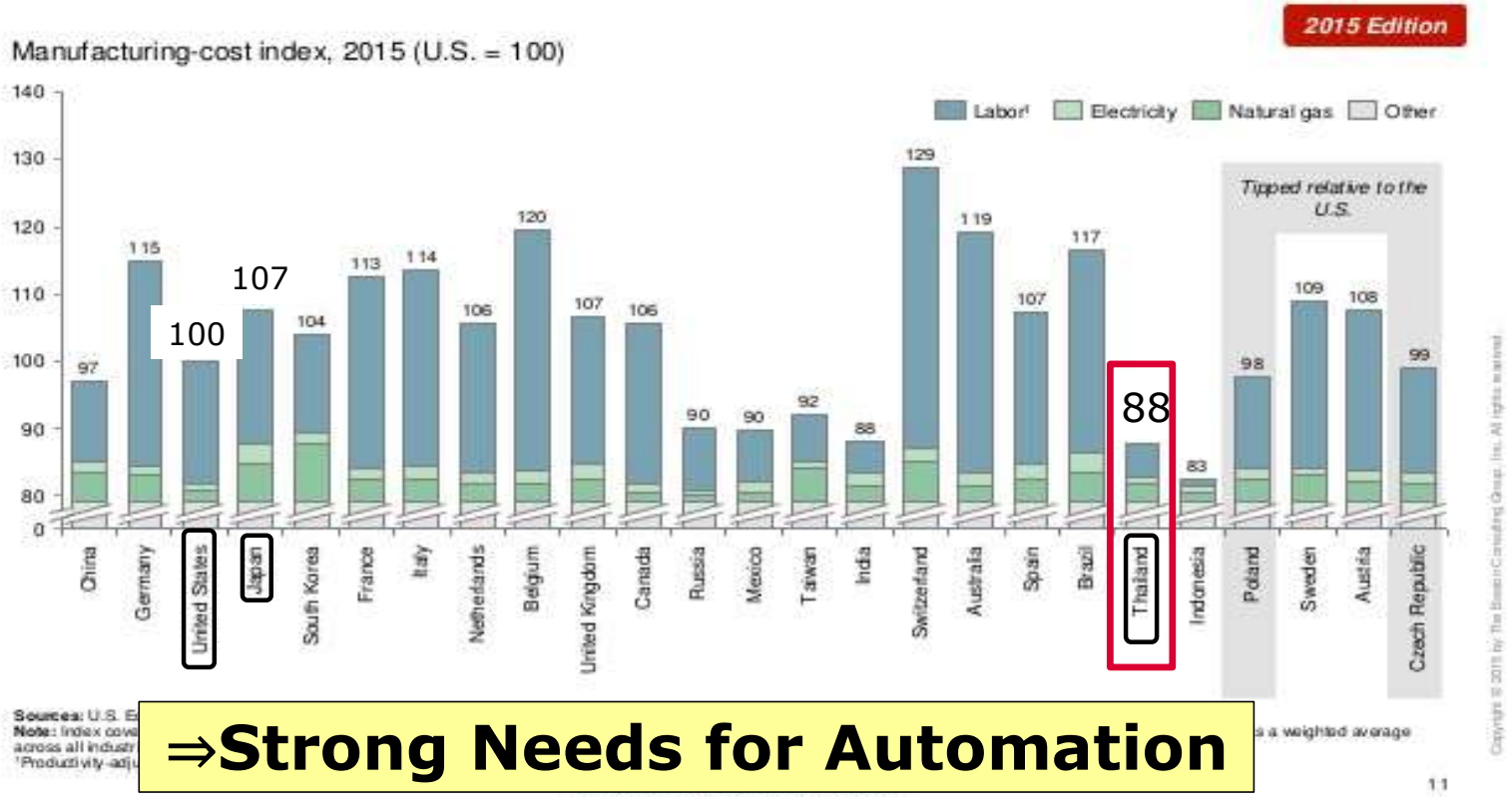
Automotive Production･Sales･Export Number in Thailand

LASI
Lean Automation System Integrators

CONFIDENTIAL

Asian Mfg. Cost : Close to Advanced Countries

BCG's index shows the manufacturing-cost competitiveness of the top 25 export economies relative to the U.S.



⇒Strong Needs for Automation

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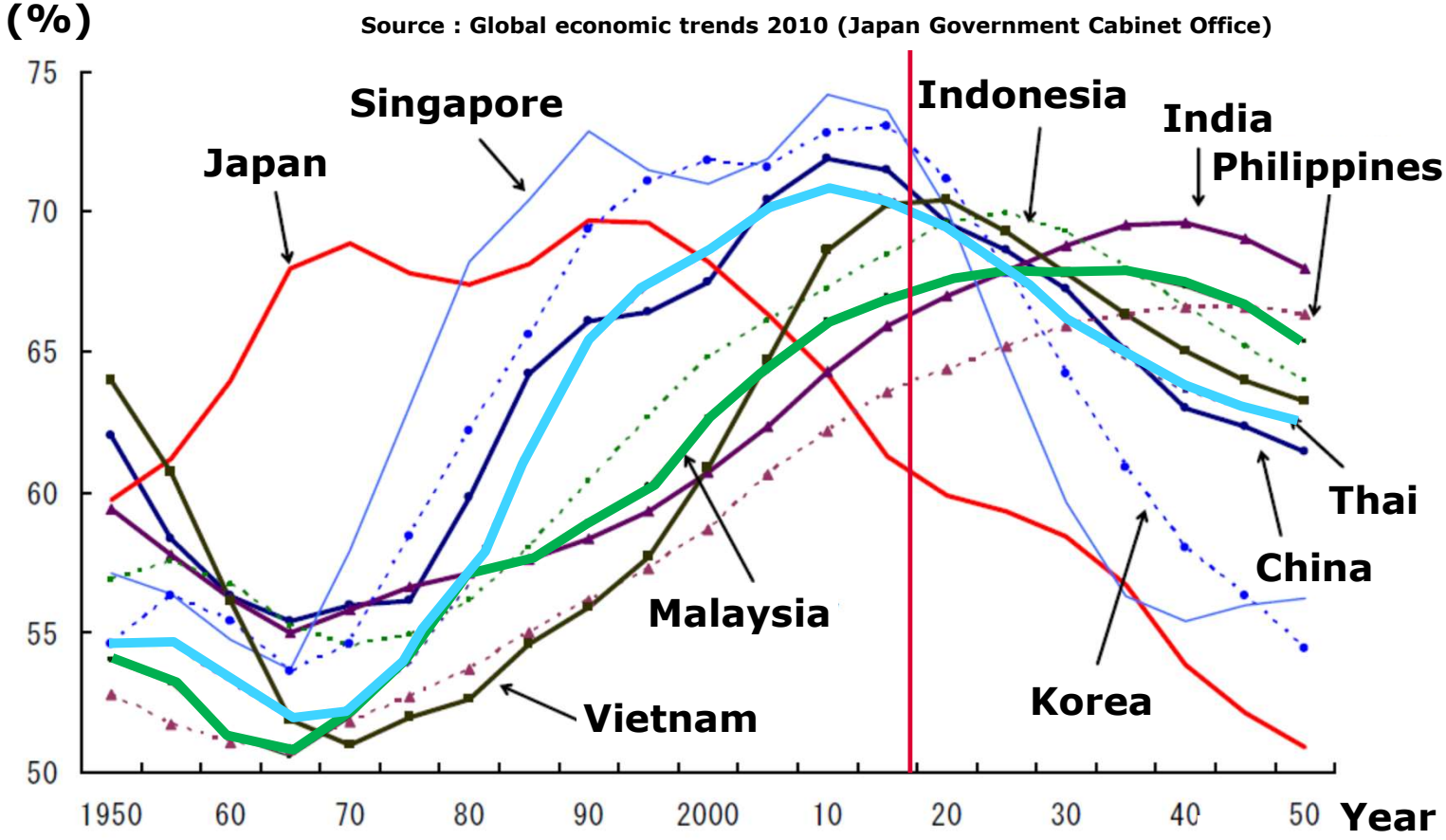
Issues of “MONOZUKURI” in Thailand (2)

Working Age Population



Industry 4.0 Industrial Revolution

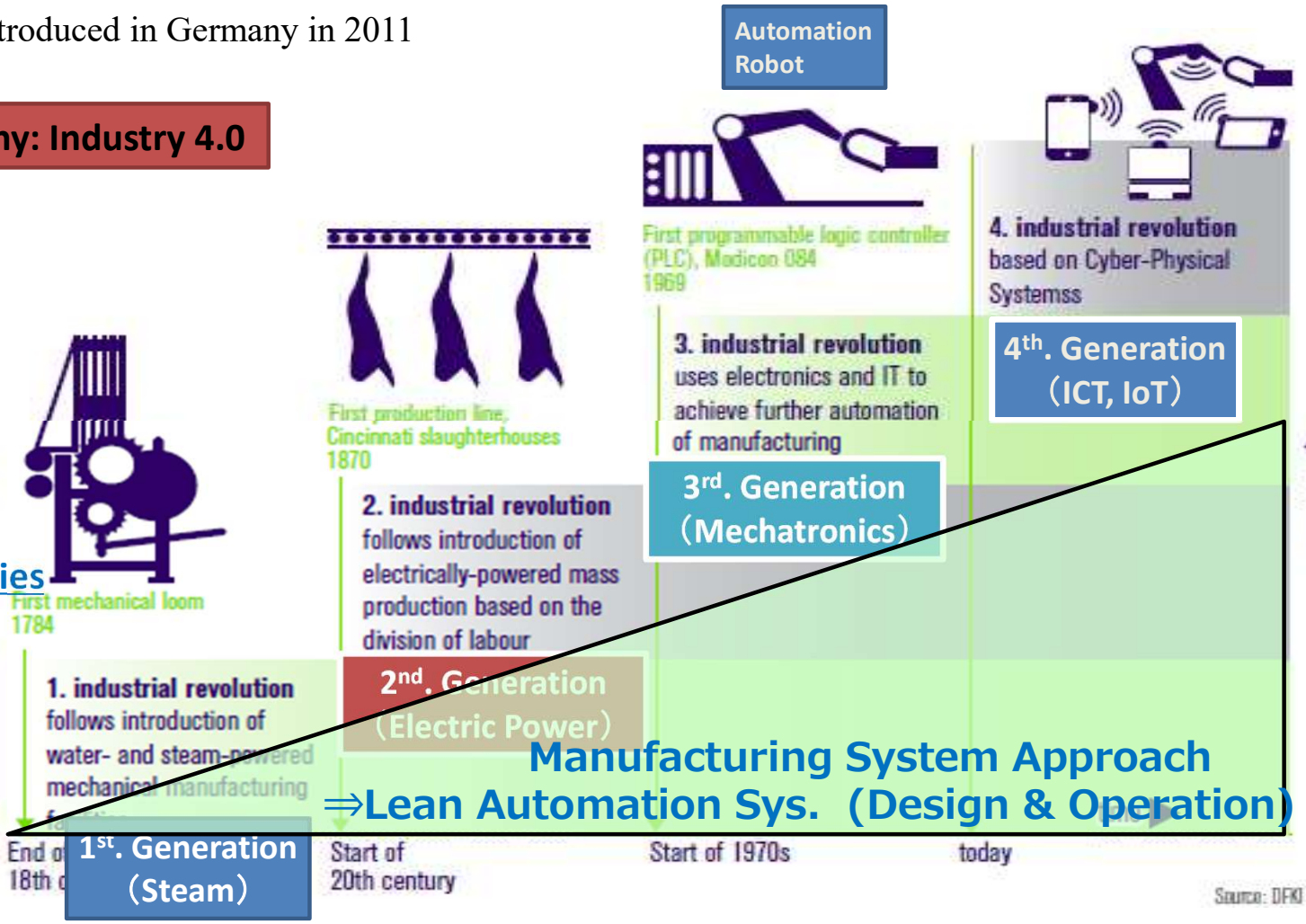
The term “Industry 4.0” is used for the industrial revolution was introduced in Germany in 2011

Germany: Industry 4.0

US: Industrial Internet Consortium

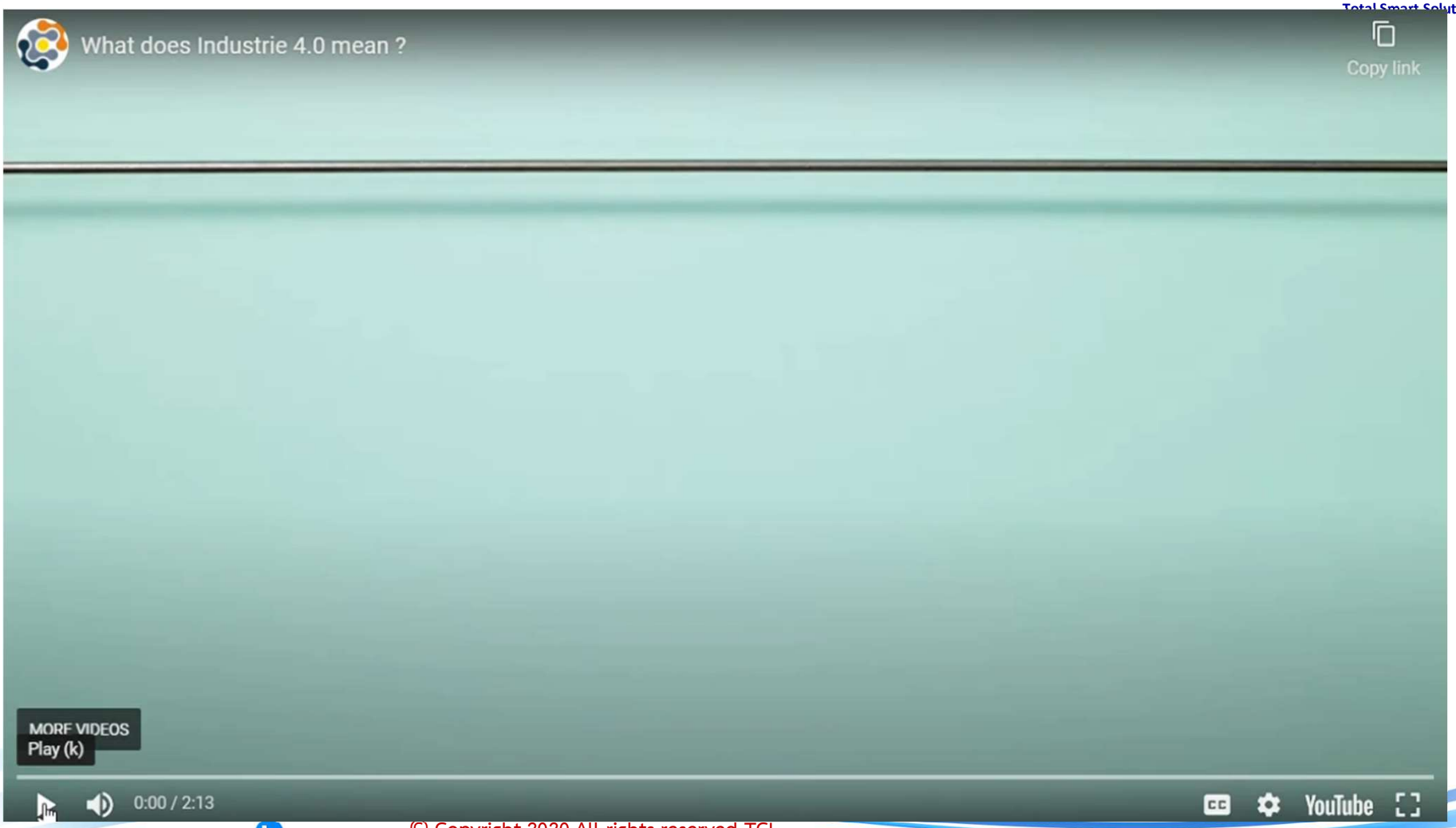
Japan : Connected Industries

Thailand : Thailand4.0



Manufacturing System Approach
⇒Lean Automation Sys. (Design & Operation)

what meaning i4.0



Definition of Industry4.0

อุตสาหกรรม 4.0 คือ **Digital transformation** ของกระบวนการทำงานในห่วงโซ่คุณค่าของอุตสาหกรรมการผลิต บริการ หรืออุตสาหกรรมที่เกี่ยวข้องผ่านกลไก **Cyber Physical System(CPS) IoT** และ **IoS** เชื่อมโยงข้อมูลกันแบบเรียลไทม์ตลอดห่วงโซ่คุณค่า ทำให้เกิด การตรวจสอบ การแจ้งเตือน วิเคราะห์ การตัดสินใจได้อย่างอัตโนมัติ แบบเรียลไทม์

What is Industry 4.0 vision?

Vision: Businesses will establish global networks

incorporate their machinery, warehousing systems and production facilities in the shape of cyber-physical systems (CPS)

CPS capable of autonomously exchanging information, trigger actions and control each other independently.

Fundamental improvements to the manufacturing processes , engineering, material usage and supply chain and life cycle management.

New approach to production already appear of Smart factory

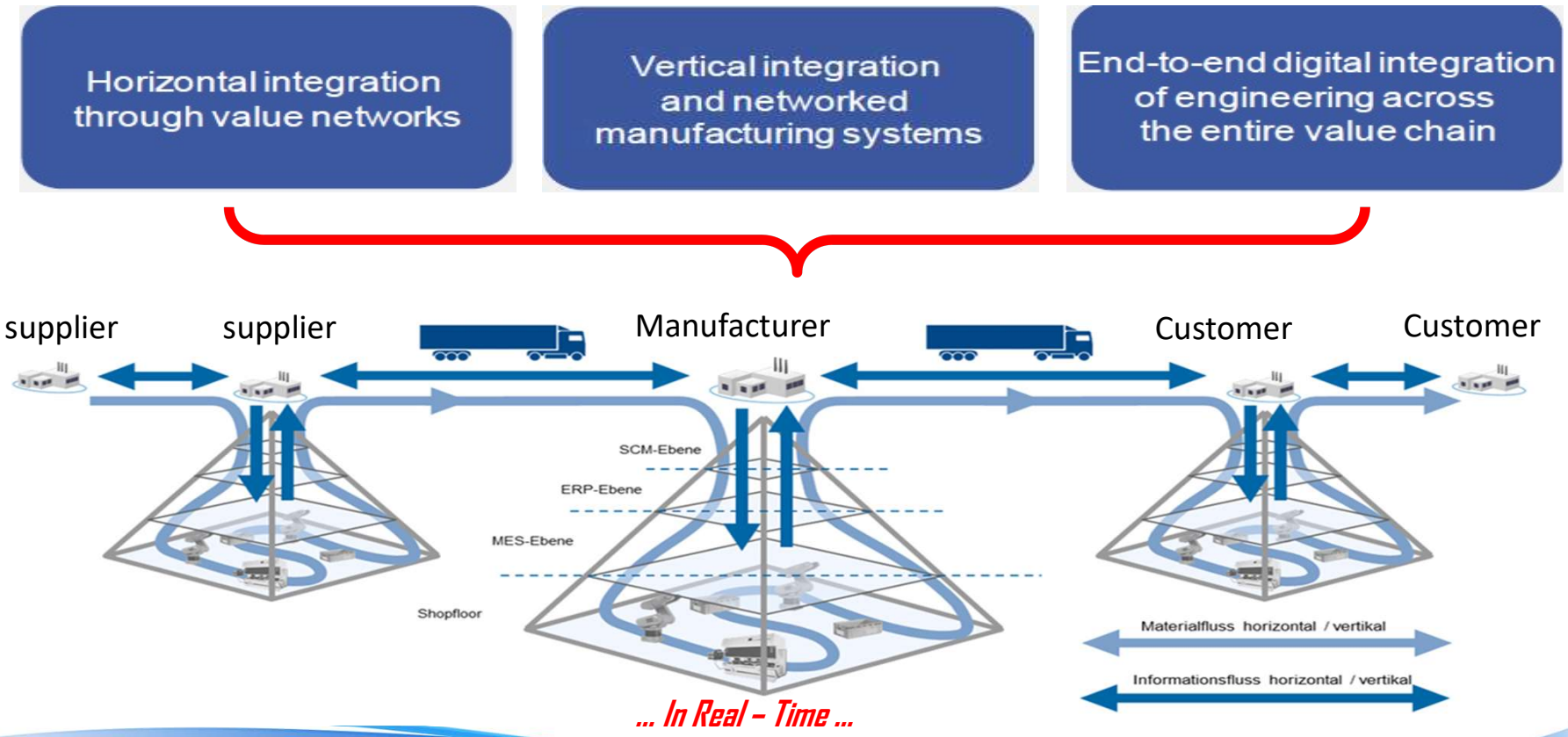
Smart products are self identifiable, located at all times and know their own history, current status and alternative routes to achieving their target state.

The embedded manufacturing systems are vertically networked with business processes within factories and enterprises

And Horizontally connected to dispersed value networks that can be managed in real time—from the moment an order is placed right through to outbound logistics.

In addition require end-to-end engineering across the entire value chain

The Key Characteristics of Industry 4.0 for process integration



• Horizontal network connections

Communication is realized not only within one factory, but throughout the whole supply chain, between the suppliers, manufacturers and service providers. The main purpose is to enhance the efficiency of production and to utilize the resources in a more economical way.

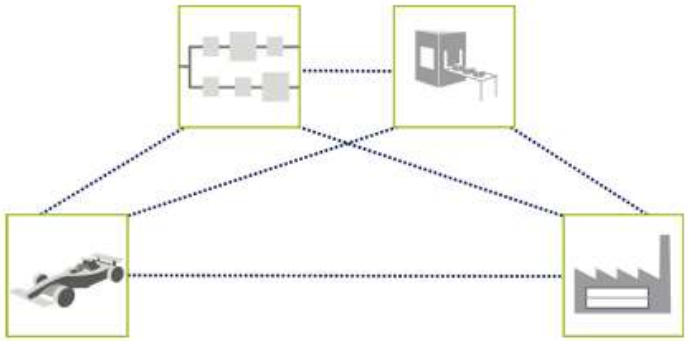
• Vertical network connections

After processing the customer's unique specifications for the product to be manufactured, the production control system forward automated rules to the equipment. Essentially, the products control their own manufacturing process, as they communicate with the equipment, devices and other workpieces on the conditions of production.

End-to-End engineering across the entire value chain

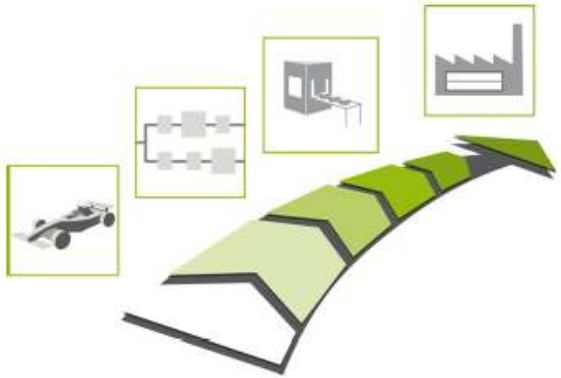
- Today -

Extensive interfaces
between IT support systems



- Industrie 4.0 -

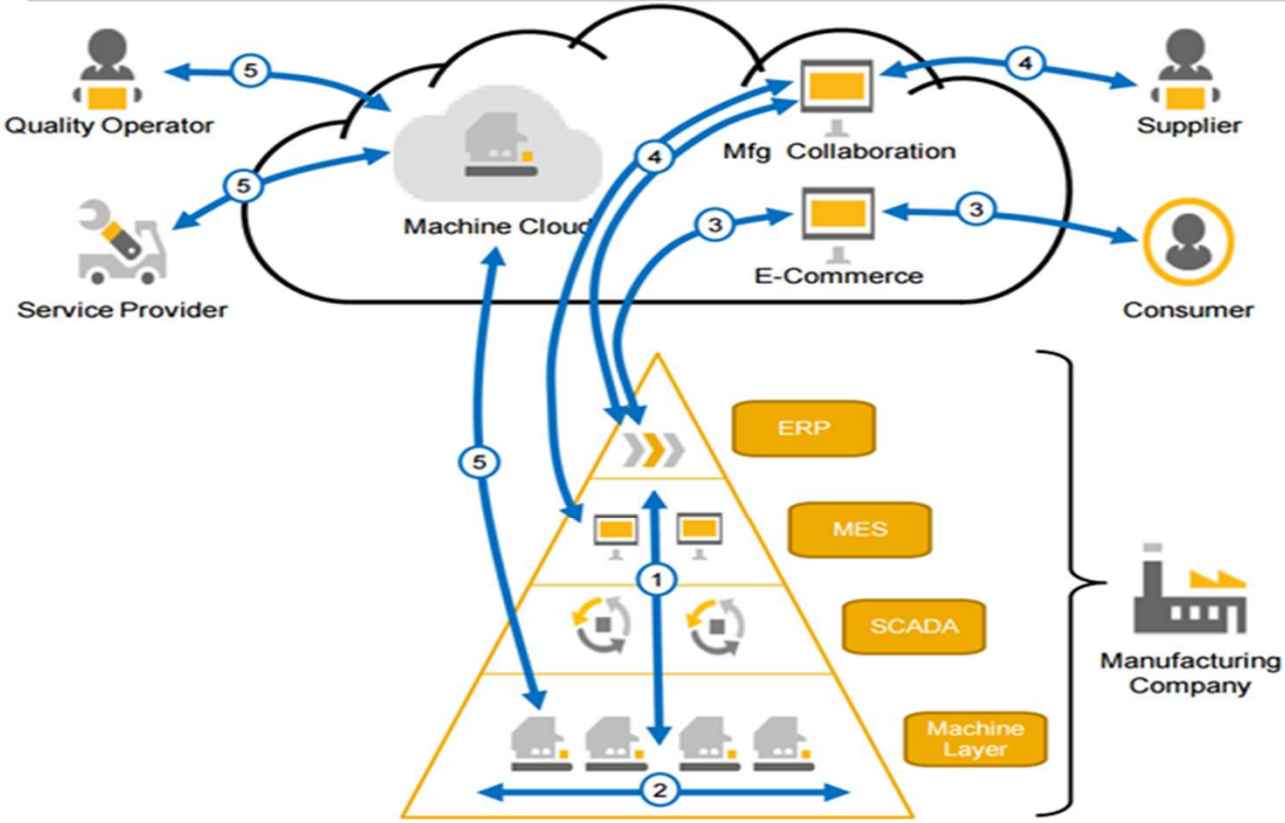
End-to-end system engineering
across the entire value chain



Tailor-made products. Customers virtually design the product themselves.

Source: Industrie 4.0 | Controlling in the Age of Intelligent Networks*, **International Performance Research Institute***

Connected Manufacturing
5 Scenarios of "Connectedness"



5 Scenarios:

1. **Shop floor to Top floor**
   Intra company vertical integration

2. **Machine to Machine**
   Autonomous machines

3. **eCommerce Integration**
   Direct integration of online configurators

4. **Manufacturing Collaboration**
   - Visibility
   - Genealogy
   - Quality
   - Kanban / Direct replenishment

5. **Machine Cloud**
   - Predictive maintenance
   - Predictive quality

Key characteristic of Industry 4.0 for network production

The idea of the Smart product is to extend the role of a product so that it becomes an active rather than passive part of the system. Products have memory in which operational data and requirements are stored so that the product itself requests the required resources of the production processes required for its completion. The ultimate goal is the creation of self configuring processes in highly modular production systems

smart machine, machines become cyber-physical production systems. The traditional production hierarchy is replaced by a decentralized self-organization enabled by CPS

machines are able to self-organize within the production network. Production lines are so flexible and modular that even the smallest lot size can be produced under conditions of highly flexible mass production. A CPS-based modular production line allows an easy plug-and-play integration or the replacement of one production line with a new manufacturing unit, e.g., in the case of reconfiguration

The augmented operator targets the technological support of workers in the challenging environment. Industry 4.0 is not gravitating toward worker-less production facilities. Human operators are acknowledged as the most flexible parts of a production system, as they can adapt to challenging work environments

Benefit of Industry 4.0

แนวคิดอุตสาหกรรม 4.0 มีการนำไปใช้หลายแง่มุม
ตัวอย่าง หุ่นยนต์ประกอบชิ้นงานที่ทำงานร่วมกับชุดขันสกรู ซึ่งก็จะมีการสื่อสารกัน
รถยกที่ขับเคลื่อนด้วยตัวเอง (self-driving forklifts) ทำงานร่วมกับคลังสินค้าอัตโนมัติ
เครื่องจักรอัจฉริยะที่ทำงานร่วมกันอยู่ในกระบวนการผลิตได้อย่างอิสระด้วยตนเอง
ในอุตสาหกรรม 4.0 คน เครื่องจักร และผลิตภัณฑ์ ต่างถูกเชื่อมโยงโดยตรงกับสิ่งอื่นๆในระบบ

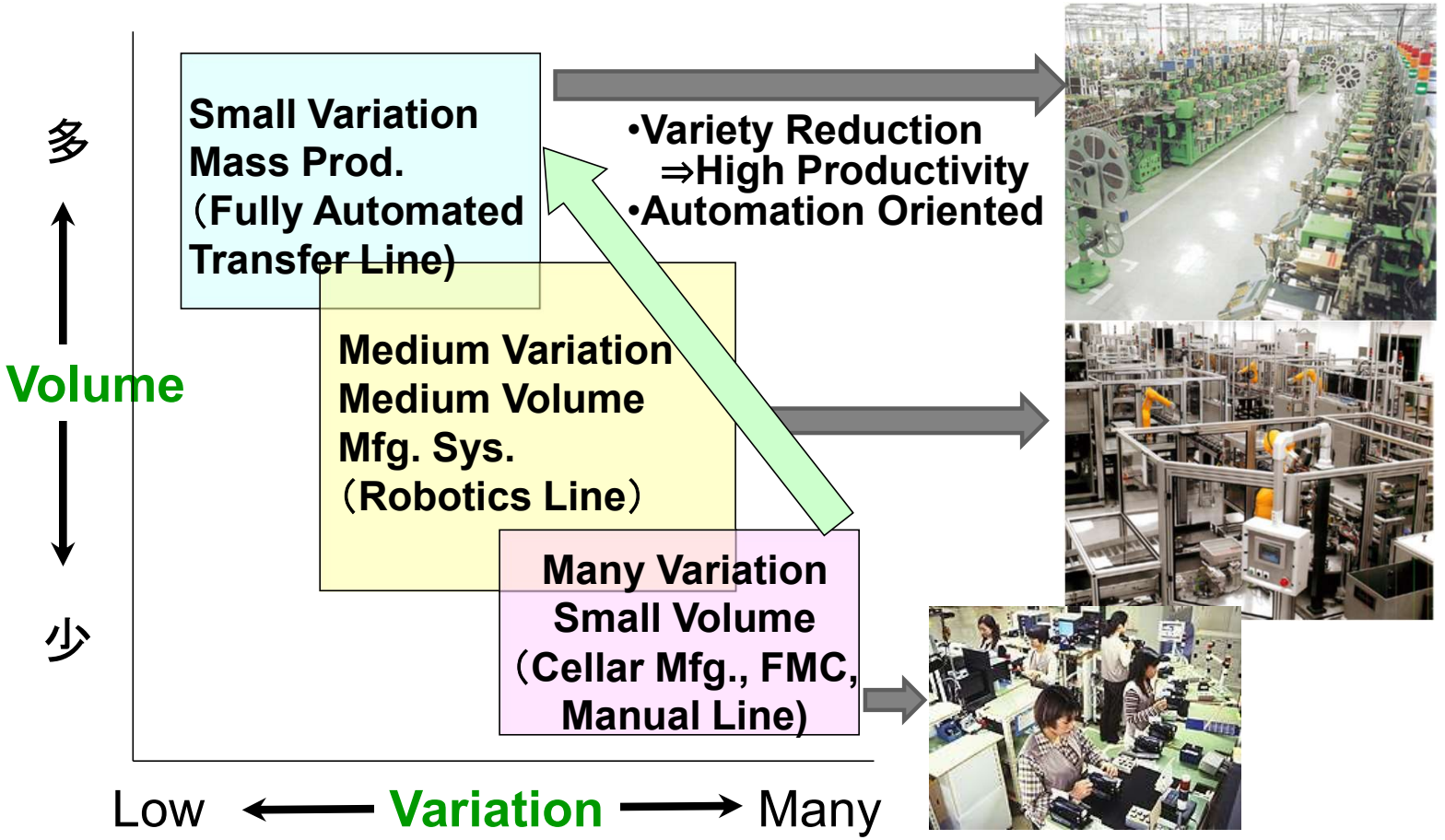
There are many ways for companies to use intelligent networking. The possibilities include:

Convertible factory: Future production lines can be built in modules and quickly assembled for tasks. Productivity and efficiency will be improved; individualized products can be produced in small quantities at affordable prices.

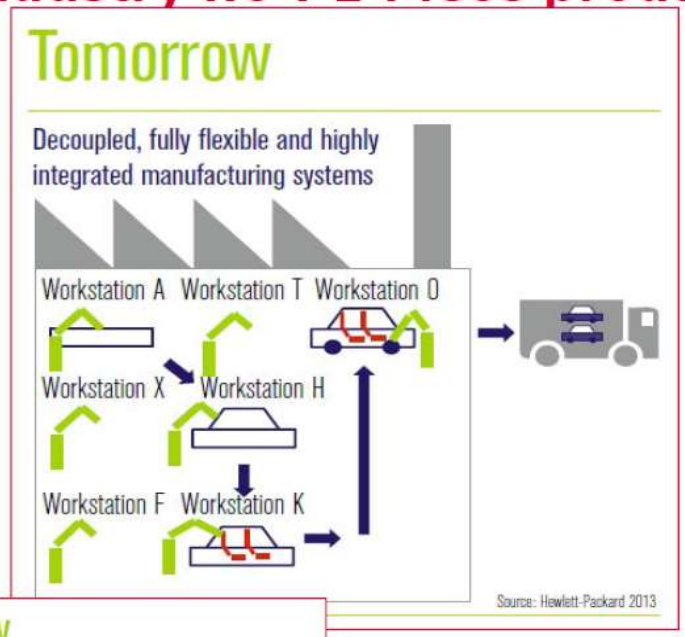
Customer-oriented solutions: Consumers and producers will move closer together. The customers themselves can design products according to their wishes—for example, sneakers designed and tailored to the customer's unique foot shape.

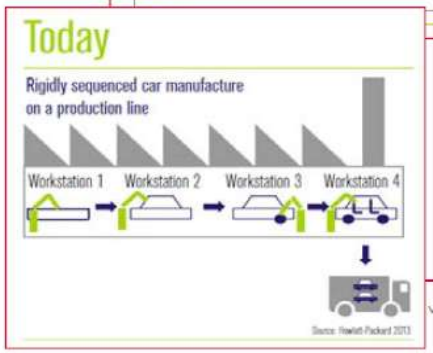
Smart products that are already being delivered and in use can send data to the manufacturer. By using these data, the manufacturer can improve his or her products and offer the customer novel services.

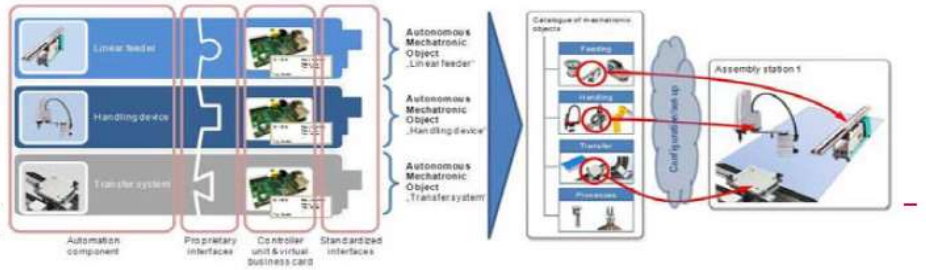
Classification of Mfg. Sys. by Volume & Variation



Industry4.0 : 1 Piece production







venue / date / pres

Benefit of Industry 4.0

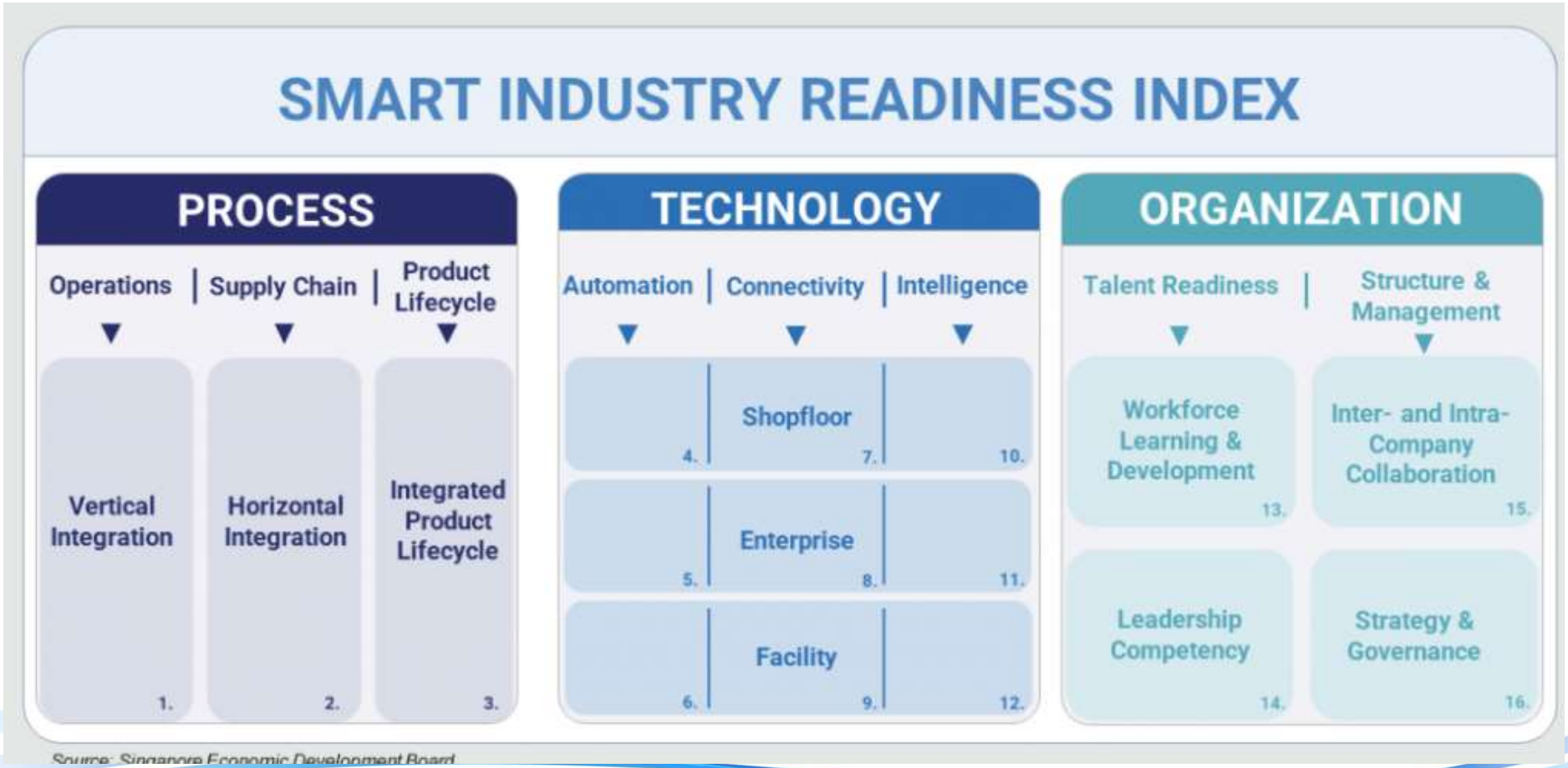
Optimized logistics: Algorithms can calculate ideal delivery routes; machines independently report when they need new material—smart networking enables an optimal flow of goods.

Use of data: Data on the production process and the condition of a product can be combined and analyzed. Data analysis will provide guidance on how to make a product more efficiently

New business models and services. For example, lift manufacturers can offer their customers "predictive maintenance": elevators equipped with sensors that continuously send data about their condition. Product wear can be detected and corrected before it leads to an elevator system failure.

I4.0 framework

i4.0 framework



Thai-German Institute

Total Smart Solutions for Your Success

Vertical integration

Horizontal integration/PLM band เหมือนกัน

Band		Definition	Description
0	Undefined	Vertical processes are not explicitly defined.	Resource planning and technical production processes are managed and executed in silos, based on informal or ad-hoc methods.
1	Defined	Vertical processes are defined and executed by humans, with the support of analogue tools.[1]	Resource planning and technical production processes are managed and executed in silos, based on a set of formally defined instructions.
2	Digital	Defined vertical processes are completed by humans with the support of digital tools.	Resource planning and technical production processes are managed and executed in silos, by Operations Technology (OT) and Information Technology (IT) systems.
3	Integrated	Digitized vertical processes and systems are securely integrated across all hierarchical levels of the automation pyramid.[2]	OT and IT systems managing resource planning and technical production processes are formally linked; however the exchange of data and information across different functions is predominantly managed by humans.
4	Automated	Integrated vertical processes and systems are automated, with limited human intervention.	OT and IT systems managing the resource planning and technical production processes are formally linked, with the exchange of data and information across different functions predominantly executed by equipment, machinery and computer-based systems.
5	Intelligent	Automated vertical processes and systems are actively analysing and reacting to data.	OT and IT systems are integrated from end to end, with processes being optimized through insights generated from analysis of data.

การวางแผนทรัพยากร และเทคนิคกระบวนการผลิต ดำเนินการแบบsilo ใช้วิธีการ เฉพาะกิจ ไม่ได้สร้างเป็นมาตรฐาน

siloใช้วิธีการ และสร้างเป็นมาตรฐาน

siloใช้คน และเทคโนโลยีOT,IT

เชื่อมโยง IT และ OT ทำด้วยHuman

เชื่อมโยง IT และ OT แบบAutomate และใช้คนอย่างจำกัด

Optimize โดยAnalysis data

Band		Definition	Description
0	None	Repetitive production[3] and support processes[3] are not automated.	Production processes are executed by humans.
1	Basic	Repetitive production processes are partially automated, with significant human intervention. Repetitive support processes are not automated.	Production processes are executed by humans with the assistance of equipment, machinery and computer-based systems.
2	Advanced	Repetitive production processes are automated, with minimal human intervention. Repetitive support processes are not automated.	Production processes are predominantly executed by equipment, machinery and computer-based systems. Human intervention is required to initiate and conclude each process.
3	Full	Repetitive production processes are fully automated, with no human intervention. Repetitive support processes are partially automated, with limited human intervention.	Production processes are fully automated through the use of equipment, machinery and computer-based systems. Human intervention is required for unplanned events.
4	Flexible	Automated production processes are reconfigurable through plug-and-play automation. Repetitive support processes are partially automated, with limited human intervention.	Equipment, machinery and computer-based systems can be modified, reconfigured, and re-tasked quickly and easily when needed. Limited human intervention is required for unplanned events.
5	Converged	Flexible production and support processes are converged with enterprise and facility automation platforms to form highly autonomous networks.	Equipment, machinery and computer-based systems are flexible and formally integrated with enterprise and facility systems, to allow for dynamic, cross-domain interactions.

Shopfloor Automation

Production & Support ใช้คน

ใช้คนและเครื่องมือช่วย เครื่องจักร และคอมพิวเตอร์

ใช้เครื่องจักรอัตโนมัติและใช้คนตอนเริ่มต้นและจบกระบวน ส่วน support ยังไม่อัตโนมัติ

ใช้เครื่องจักรทำงานอัตโนมัติใช้คนตอน Unplan ส่วน support อัตโนมัติบางส่วน

ใช้เครื่องจักร flexible สามารถ reconfig ได้ง่าย

Production & support เชื่อมโยงกับ Enterprise and Facility

Total Smart Solutions for Your Success

ส่วนของ Enterprise/Facilities Automation ใช้ Band เหมือนกัน

Band		Definition	Description
0	None	OT & IT systems are not in use.	No electronic or digital devices are used.
1	Computerized	OT & IT systems execute pre-programmed tasks and processes.	Equipment, machinery and computer-based systems are able to perform tasks based on pre-programmed logic.
2	Visible	Computerized OT & IT systems are able to identify deviations.	Equipment, machinery and computer-based systems are able to notify operators of deviations from predefined parameters.
3	Diagnostic	Computerized OT & IT systems are able to identify deviations and diagnose potential causes.	Equipment, machinery and computer-based systems are able to notify operators of deviations, and provide information on the possible causes.
4	Predictive	Computerized OT & IT systems are able to diagnose problems and predict future states of assets and systems.	Equipment, machinery and computer-based systems are able to predict and notify operators of potential deviations, and provide information on the possible causes.
5	Adaptive	Computerized OT & IT systems are able to diagnose problems, predict future states and autonomously execute decisions to adapt to changes.	Equipment, machinery and computer-based systems are able to predict and diagnose potential deviations, and independently execute decisions to optimize performance and resource efficiency.

Shopfloor intelligence

Total Smart Solutions for Your Success

Intelligence processing and analysis of that data

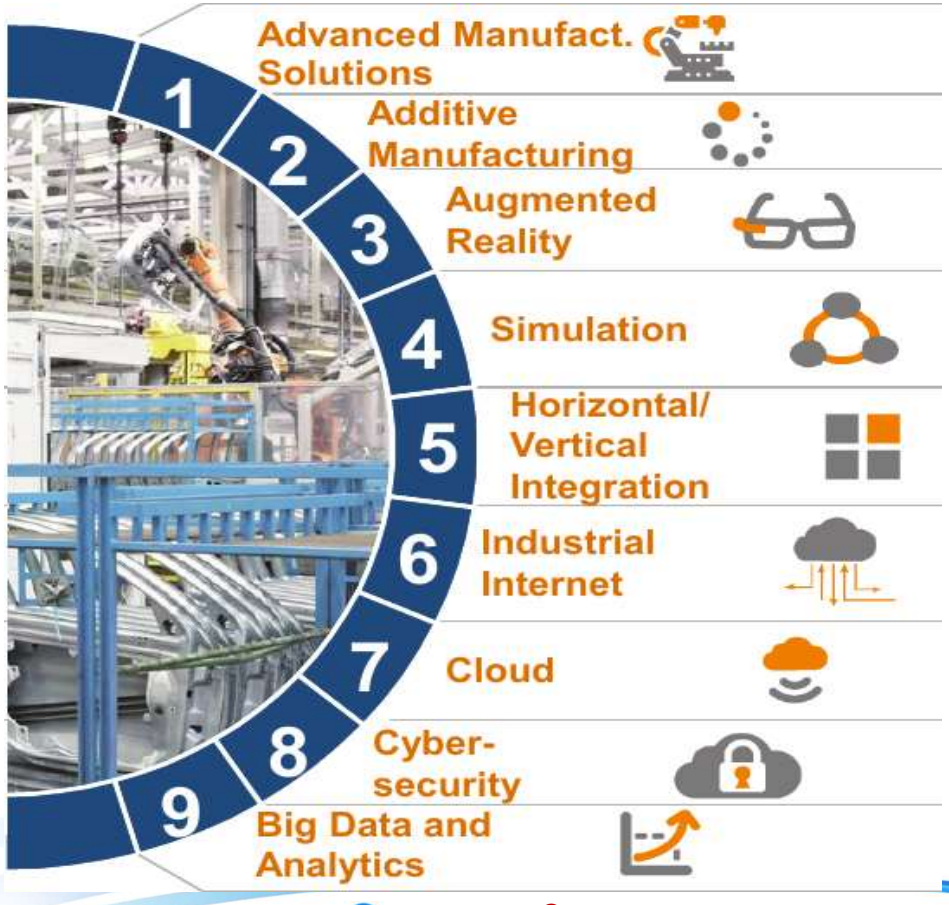
มีระบบคอมพิวเตอร์ OT&IT ที่ช่วยเตือนความผิดปกติ

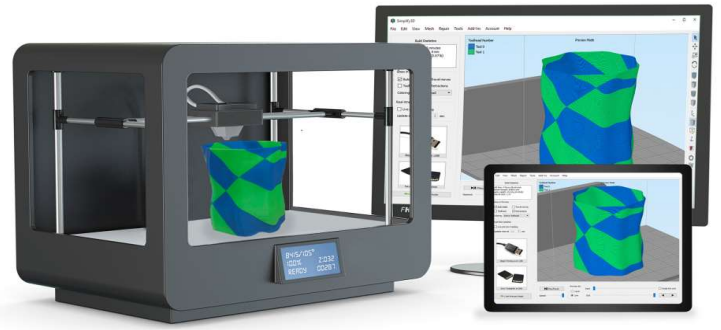
มีระบบ คอมพิวเตอร์OT&IT ที่วินิจฉัยสาเหตุที่เป็นไปได้

มีระบบคอมพิวเตอร์ OT&IT ที่คาดการณ์ แจ้งเตื่อน และวินิจฉัยล่วงหน้า

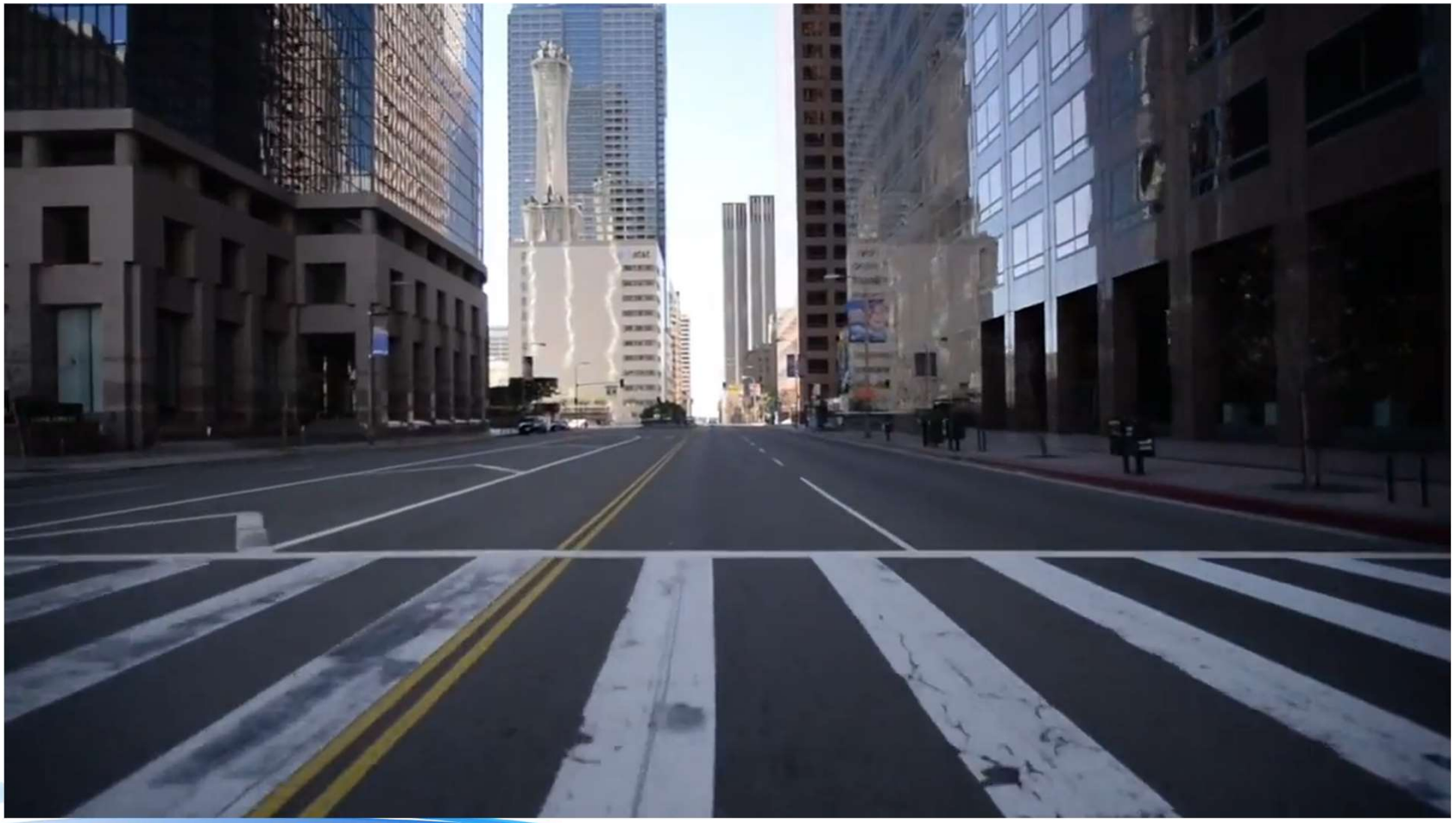
มีระบบคอมพิวเตอร์OT&IT ที่ช่วยตัดสินใจในการจัดการได้อย่างเหมาะสม

Technologies requirements and drivers of Industry 4.0





* กระบวนการผลิตแบบ Additive Manufacturing (AM) คือการขึ้นรูปชิ้นงานด้วยการเติมเนื้อวัสดุเข้าไป
* การผลิต Subtractive Manufacturing คือการขึ้นรูปชิ้นงานแบบกัดเนื้อวัสดุออก เช่น การ กลึง เจาะ กัด ไส



Source: www.youtube.com , Visteon Industry 4.0

Advanced Manufacturing System

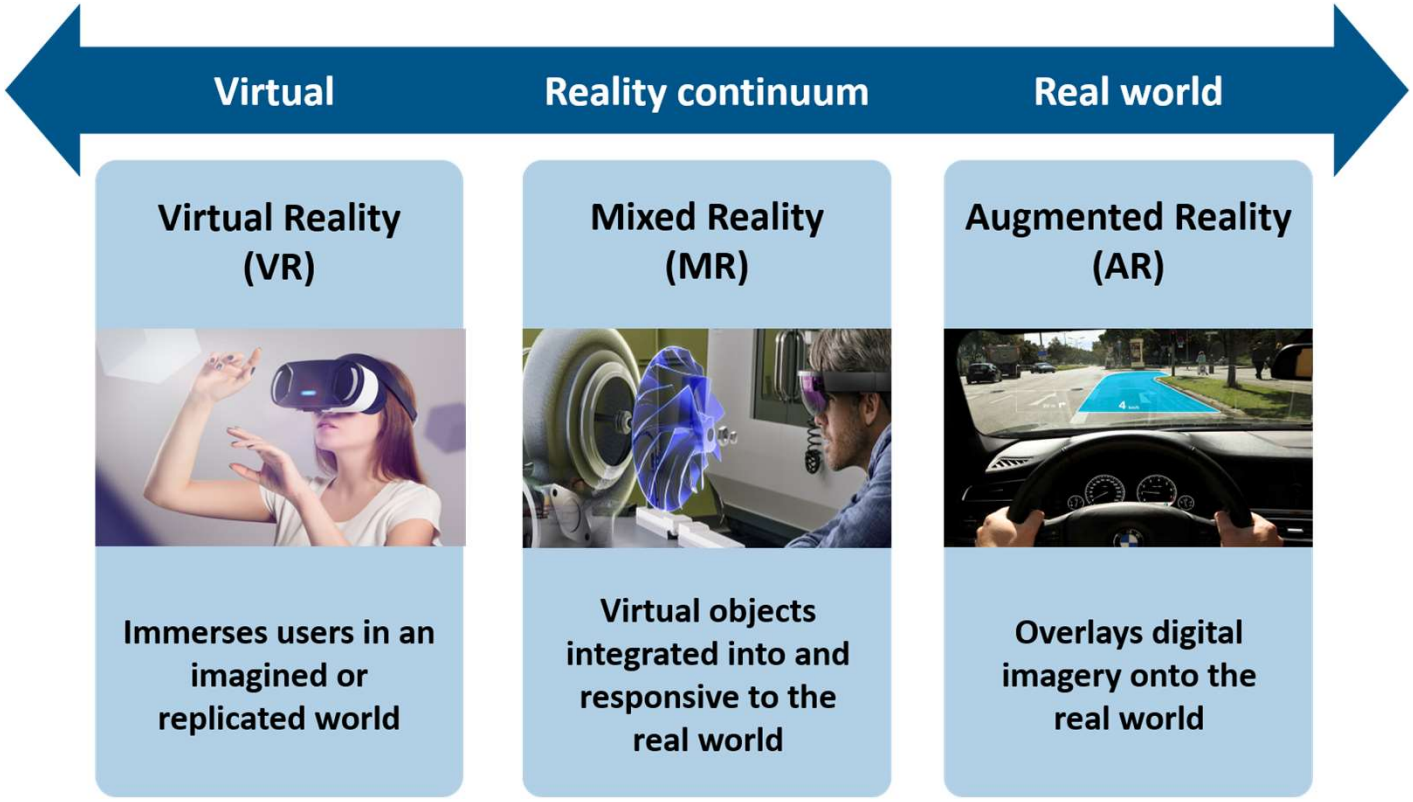
Automation benefits

- To increase productivity.
- To improve quality.
- To reduce labor cost.
- To improve safety.

Autonomous Robot

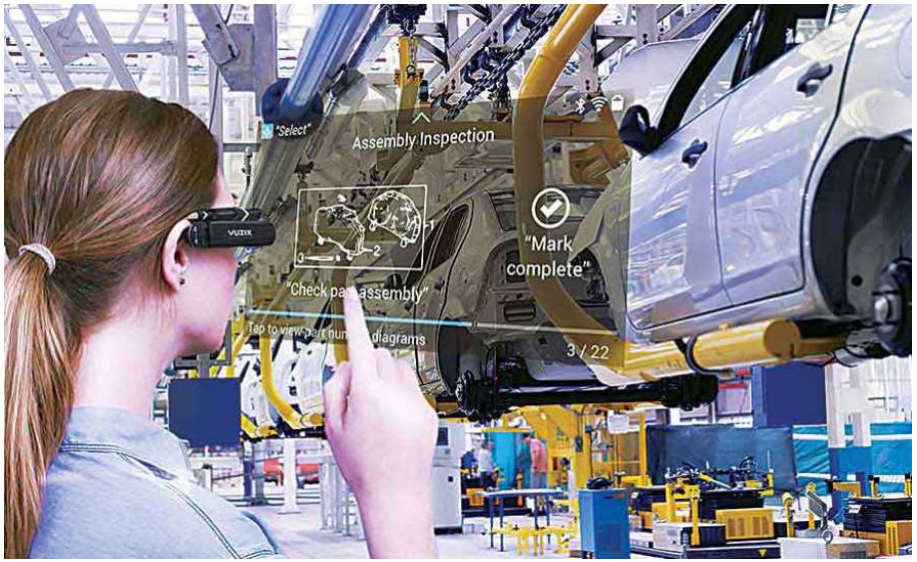
Source : www.clearpathrobotics.com/blog/2018/07/clearpath-becomes-universal-robots-certified-systems-integrator/

Augmented Reality (AR)

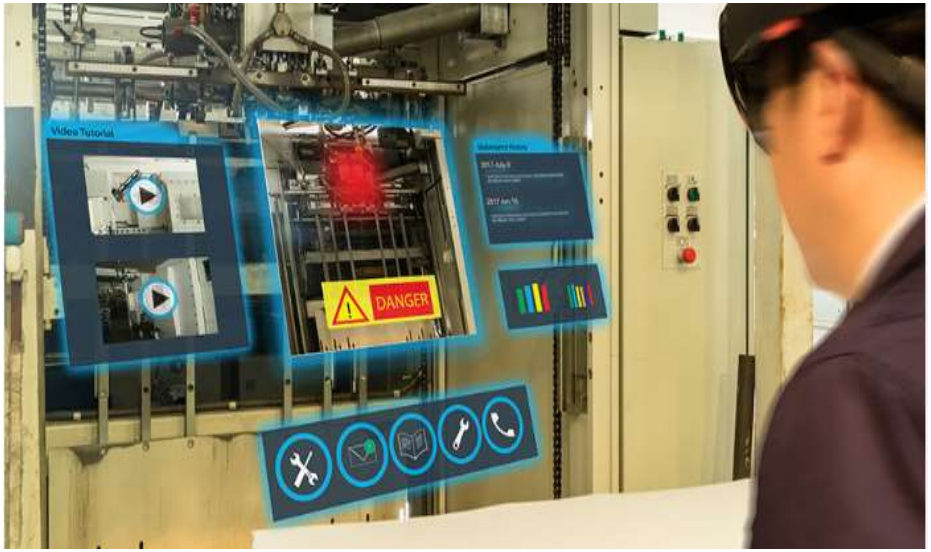


Source: https://www.deltapartnersgroup.com/new-reality-awaits-are-ar-and-vr-next-big-platforms

AR transformational use cases

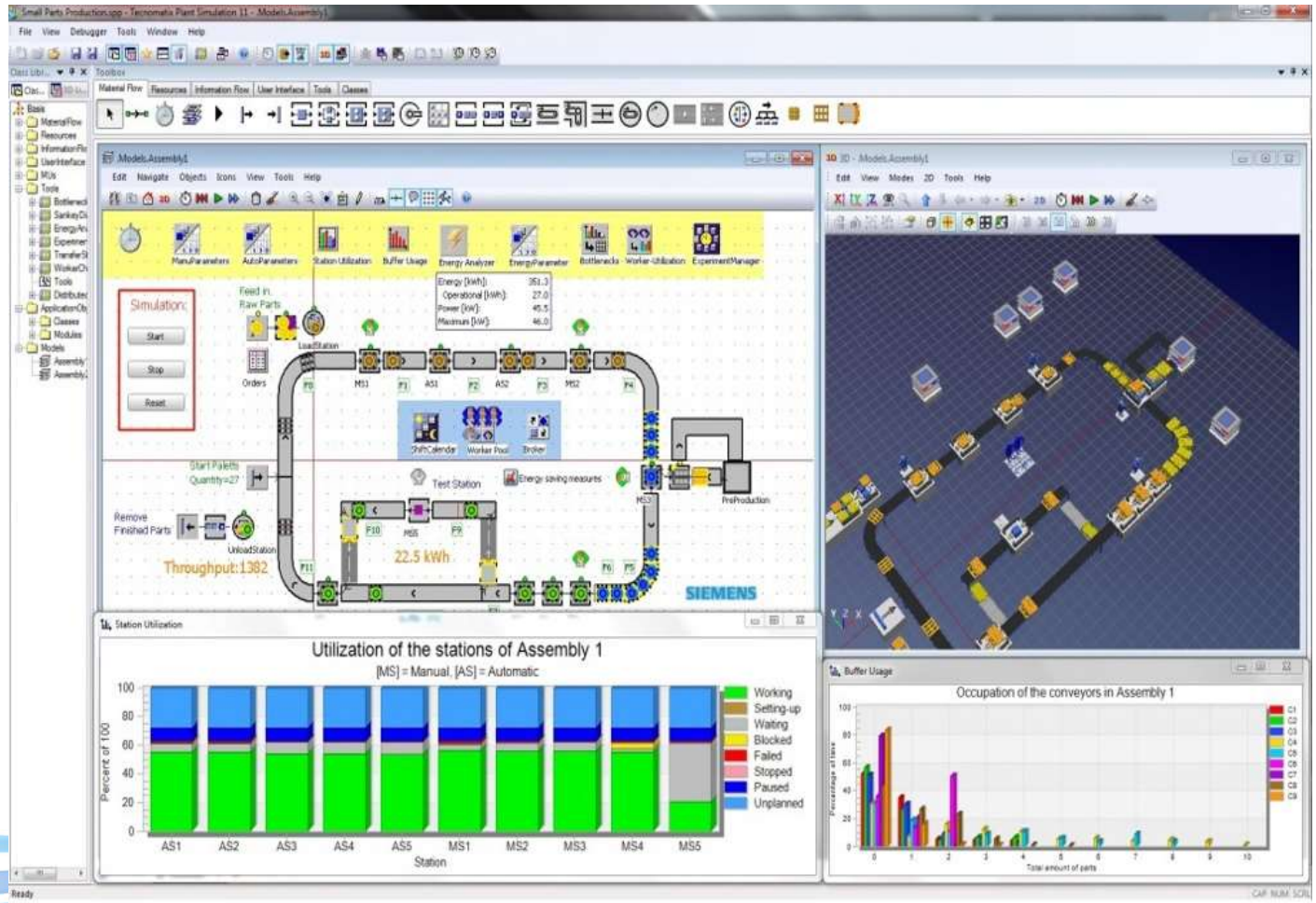


Source: https://www.assemblymag.com/articles/94979-the-reality-of-augmented-reality



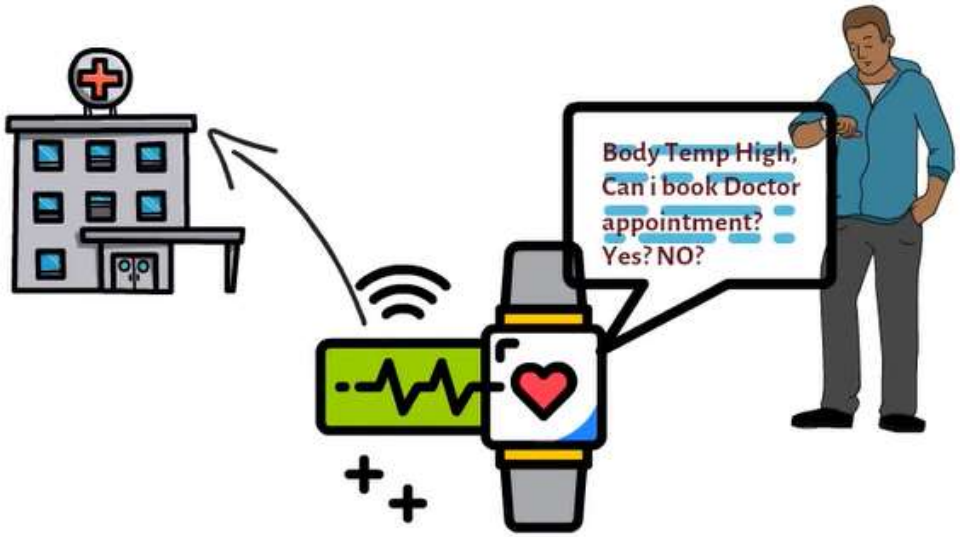
Source: https://www.ptc.com/en/thingworx-blog/4-ways-technology-can-improve-worker-safety

Simulation



Internet Of Things (IOTs)

Its a network of Physical Objects. that are able to collect data with help of sensors and exchange data each other with help of internet.



Technology
In Short