IfM Briefing Day
12 May 2016

Global Trends in the Digitalisation of Manufacturing

Definitions, priorities & policies

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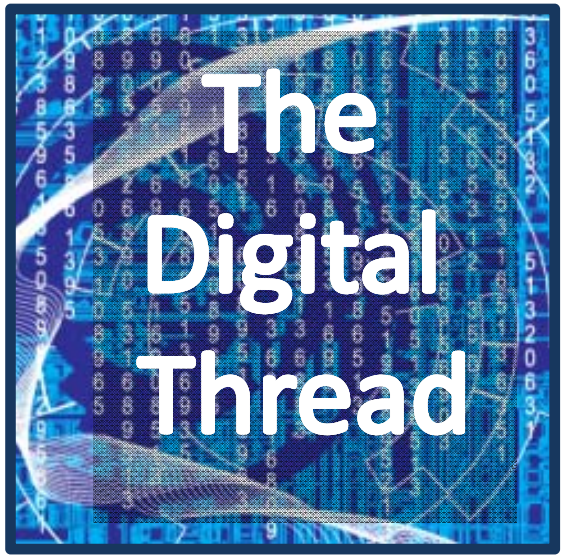
Centre for Science, Technology & Innovation Policy, IfM

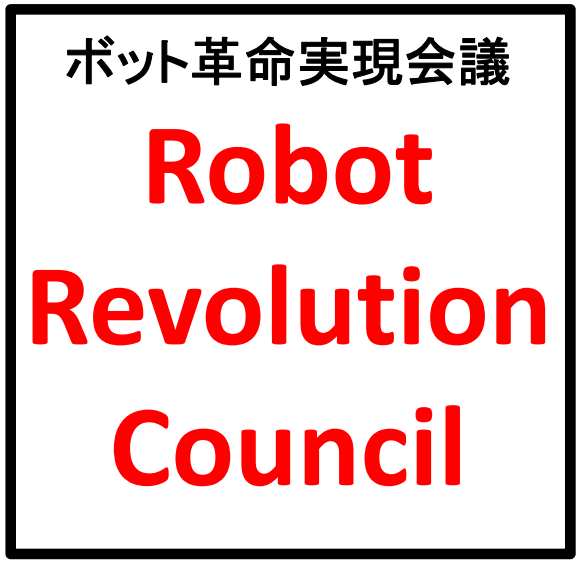
IfM MANAGEMENT TECHNOLOGY POLICY

CSTI Science Technology Innovation Policy

Talk Outline

- **Centre for Science, Technology & Innovation Policy:** What do we do?
- **Digitalisation of Manufacturing:** What is it?
  (From perspective of international advanced manufacturing policies)
- **Trends & Drivers:** What's new? What's the future?
- **Country perspectives:** Where's the value? What are they doing?





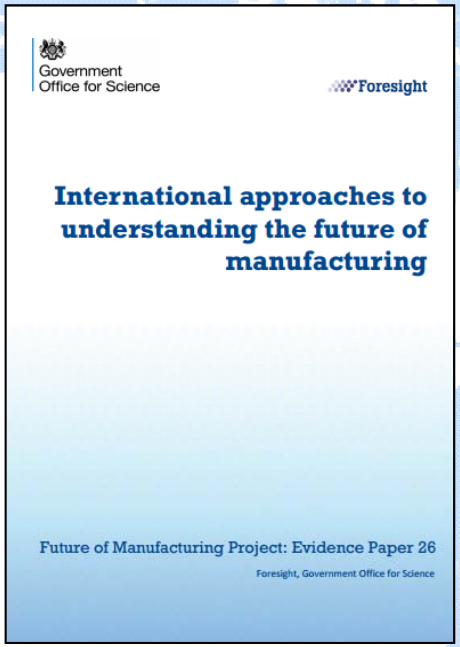
Centre for Science, Technology & Innovation Policy

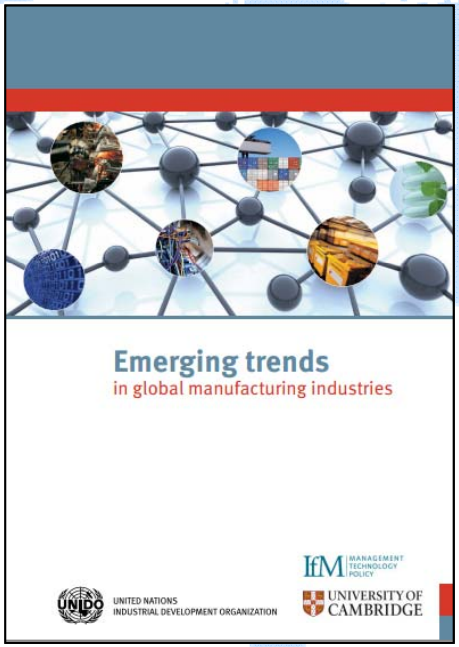
An engineering contribution to STI policy

BIS Department for Business Innovation & Skills
EPSRC Engineering and Physical Sciences Research Council
Innovate UK
bsi.
hefce
Government Office for Science

International Benchmarking

Foresight, Policy Trends & R&D Prioritisation





Government Office for Science

UNIDO

EPSRC
Pioneering research and skills

Digitalisation of Manufacturing

Different National Approaches

Overview of these documents:

Key messages, themes, priorities

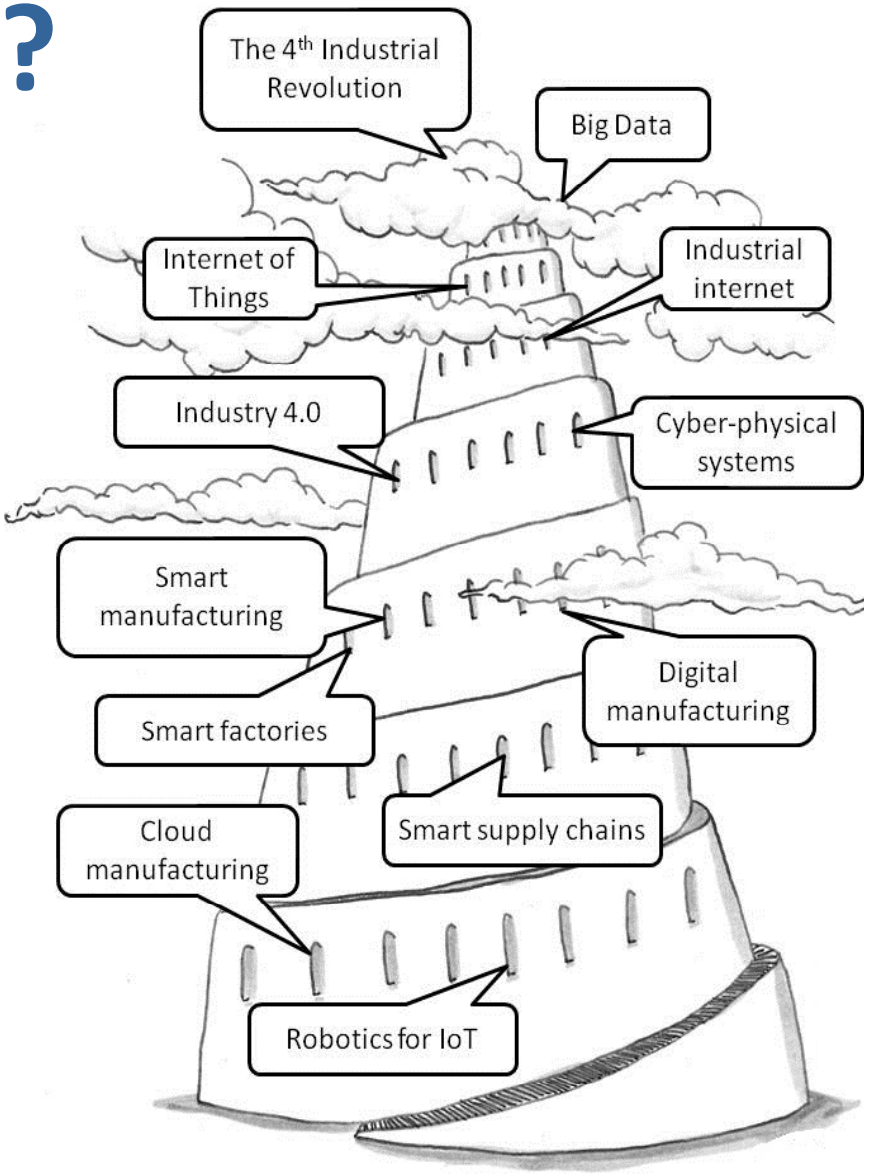
Digitalisation of Manufacturing

Why Policy Makers Interested?

- Potential to enhance productivity / growth
- Implications for manufacturing jobs (for high wage economies)
- Concerns about disconnect between manufacturing and design/innovation
- Cyber security of industrial systems and utilities
- Cost, security & supply constraints, sustainability of natural resources
- Potential for new markets

Digitalisation of Manufacturing

What does it mean?



The Digital Manufacturing Tower of Babel

Digitalisation of Manufacturing

First... some Definitions

Internet of Things

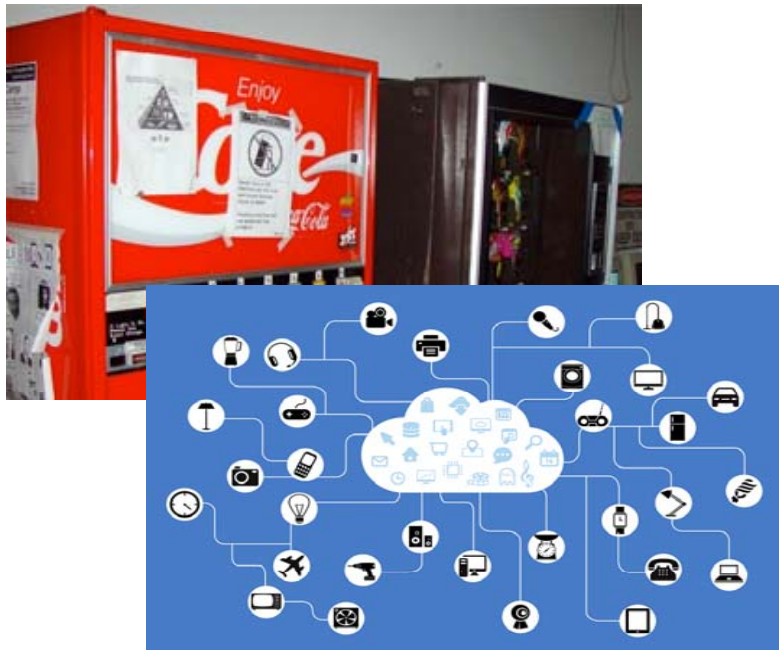
Cyber Physical Systems

Big Data

Digitalisation of Manufacturing

Definitions: Internet of Things

Internet of Things (IoT): Network of physical objects (devices, vehicles, buildings, equipment, etc) embedded with electronics, software, sensors, and connected to internet, enabling objects to collect and exchange data.



Gartner

26 billion devices that connect to the Internet by 2020

CISCO

50 billion devices connected IoT by 2020

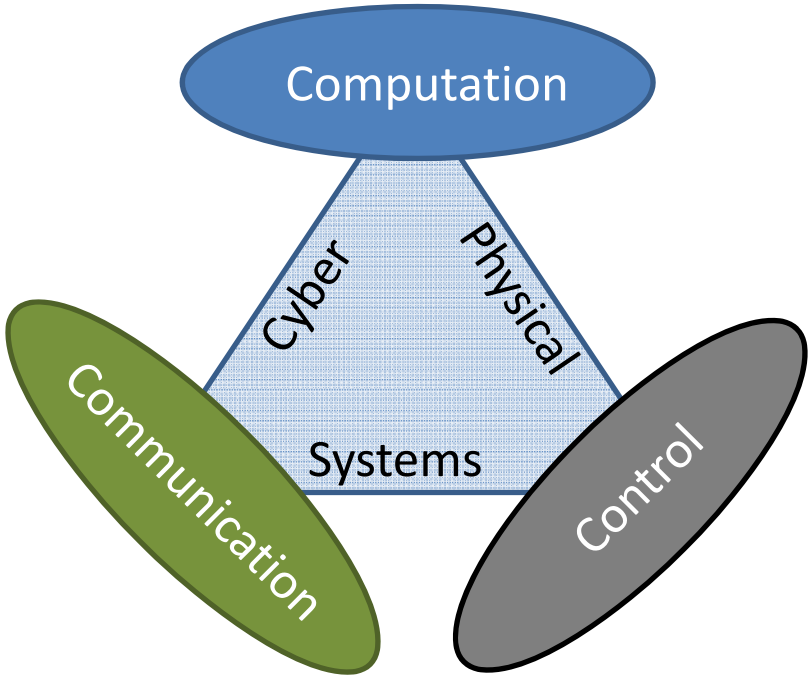
IDC
Analyze the Future

Installed base for IoT **~200 billion devices** by 2020

Digitalisation of Manufacturing

Definitions: Cyber-Physical Systems

Cyber Physical Systems (CPS): Smart networked systems with embedded sensors, processors and actuators, designed to sense and interact with physical world (including human users), and support real-time, guaranteed performance in applications.



Digitalisation of Manufacturing

Definitions: Big Data

Big Data (technology): new software tools and database systems for large, unstructured datasets; and refining analytical tools so that they can process vast quantities of data in near-real time

Everyone talks about it, nobody really knows how to do it, everyone thinks everyone else is doing it, so everyone claims they are doing it. "

Professor Dan Ariely
Duke University

Digitalisation of Manufacturing

Technology Trends

- **Digital Trends**
  - Big data analytics
  - Integrated information systems
  - Cloud computing
  - Wireless communications
  - Embedded software/sensors
  - Internet of things
  - Mobile computing
  - Apps / Internet of services
- **Manufacturing Trends**
  - Advances in robotics
  - Cyber-physical systems
  - Integrative production technologies
  - 3D printing / Additive mfg
  - Web-based everything
  - Embedded software/sensors
  - Industrial internet

Organising, sharing and analysing data

Sensing and interacting with material world

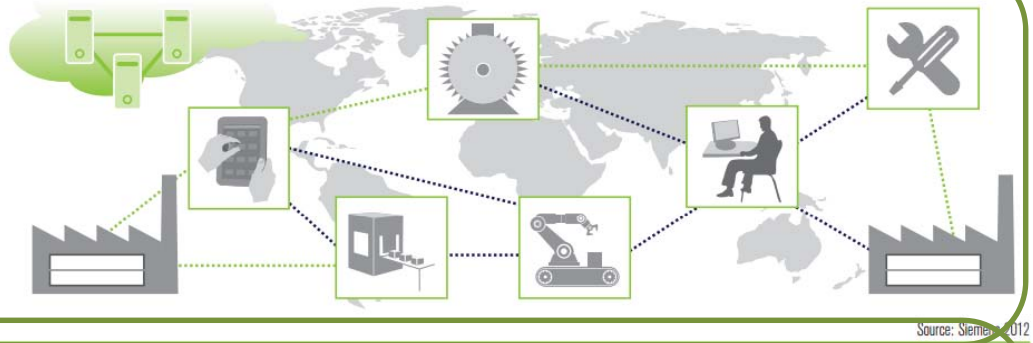
Connectivity, data gathering, control

Digitalisation of Manufacturing

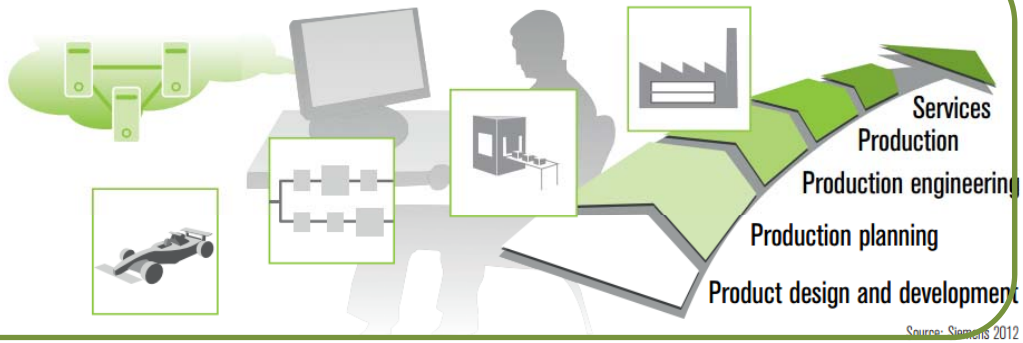
Connectivity & Integration

Vertical integration
and networked, flexible manufacturing systems

Horizontal integration
through inter-firm value chains and networks



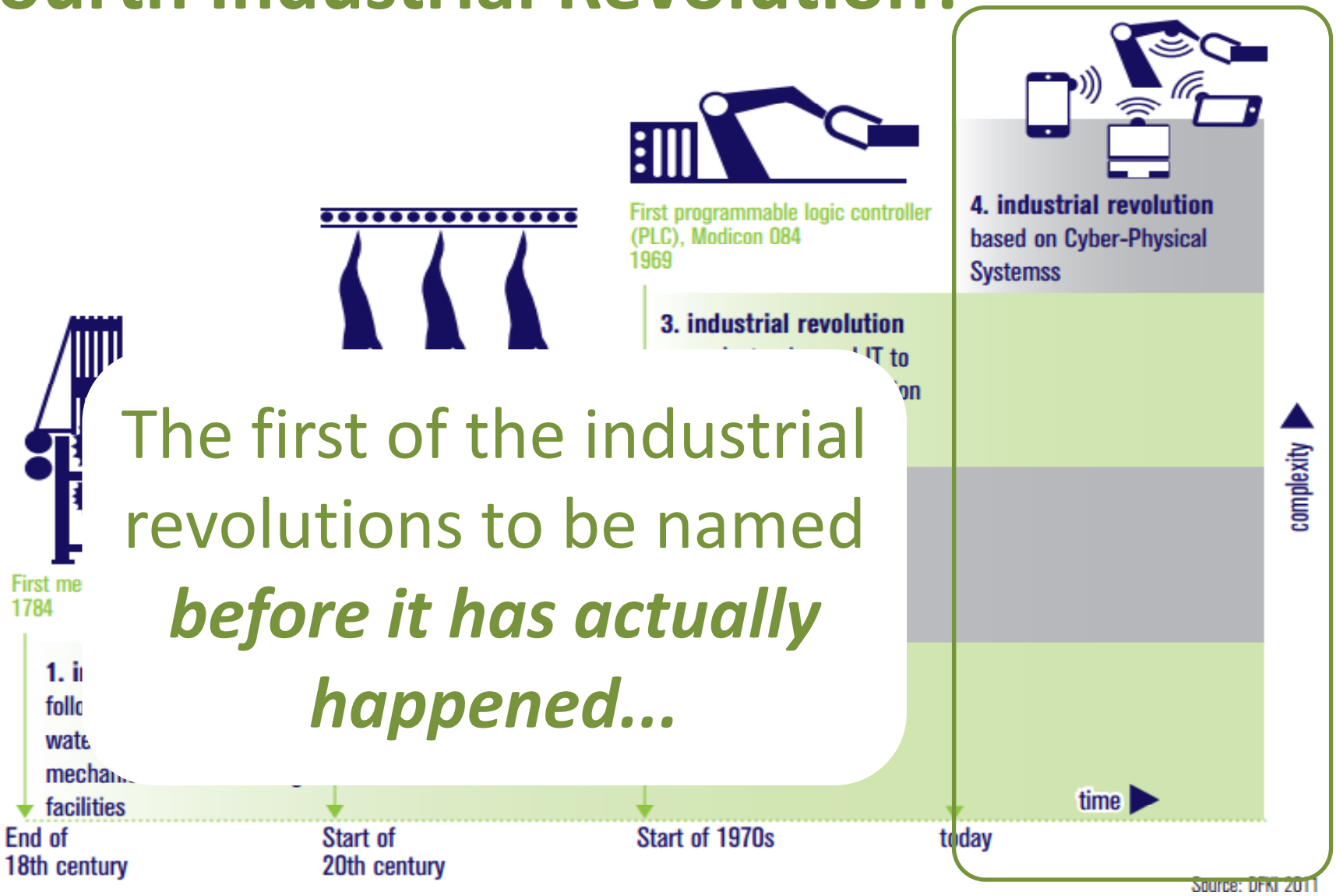
End-to-end engineering
across the entire product lifecycle / value chain



Source: Acatech, 2013. *Recommendations for Implementing Strategic Initiative INDUSTRIE 4.0*

Digitalisation of Manufacturing

A Fourth Industrial Revolution?



The first of the industrial revolutions to be named ***before it has actually happened...***

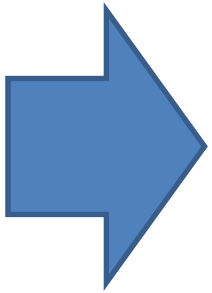
Source: Acatech, 2013. *Recommendations for Implementing Strategic Initiative INDUSTRIE 4.0*

Digitalisation of Manufacturing

What could the future look like?

Potential future of digitalised manufacturing

- Stronger (digital) links between design and production
- Fully inter-connected machines, factories and supply chains
- Transparency into supplier factories
- Data gathered, analysed and acted upon across the entire product life-cycle
- Big data analytics and increased network connectivity leveraged for greater efficiency / productivity



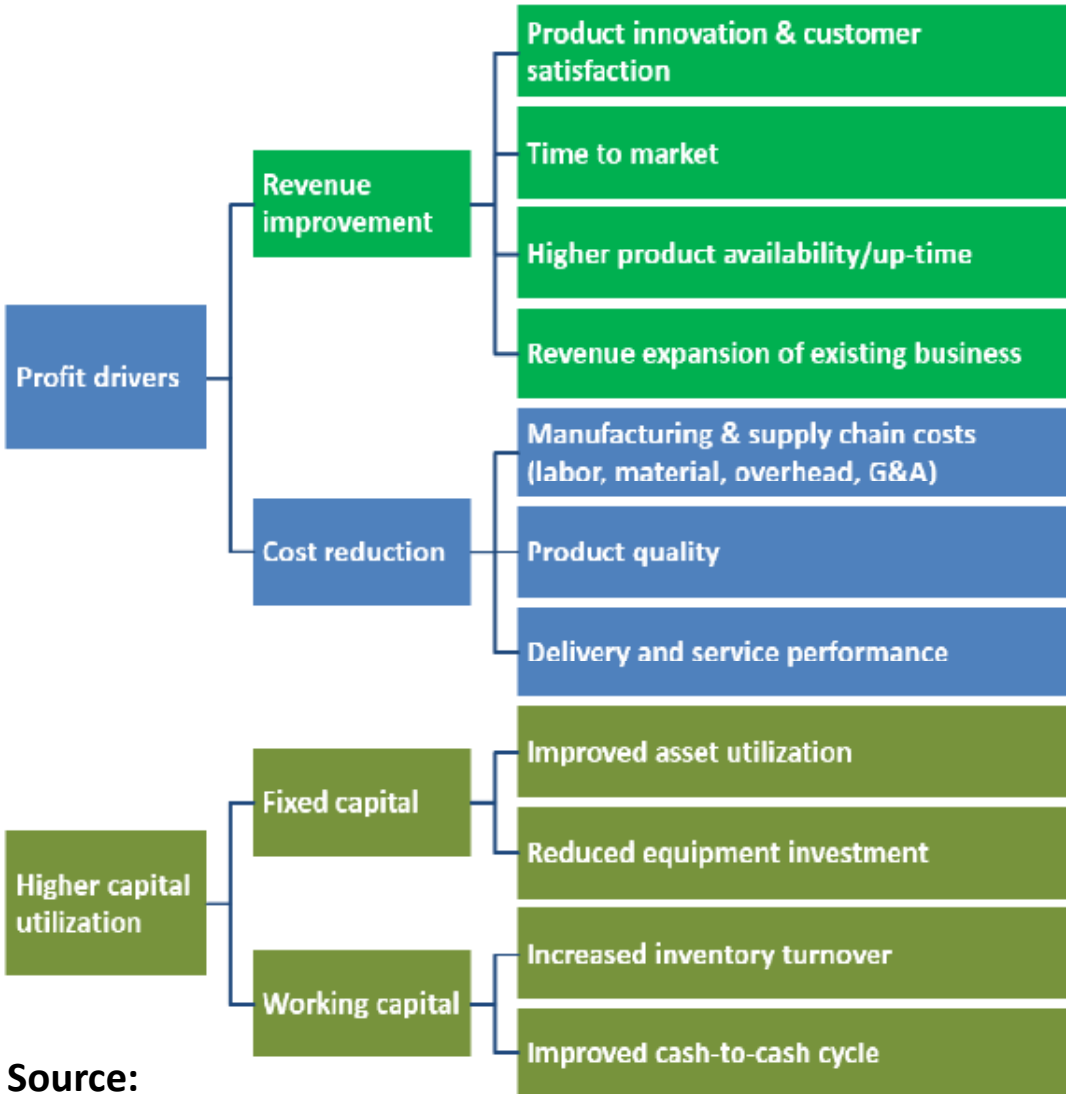
Drivers of manufacturing competitiveness

- Efficiency
- Quality
- Price
- Flexibility / agility
- Speed of response
- Reduction in defects
- Reduction in downtime
- Speed of NPD

Sources: Adapted from William P King, DDMI (2015); Forschungsunion / acatech (2013); et al.

Digitalisation of Manufacturing

Where's the value?



Drivers of manufacturing competitiveness

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Source:

Wiliam P. King (2015). *Digital Manufacturing.* Digital Manufacturing & Design Innovation Institute presentation
http://www.nist.gov/el/msid/upload/18_wKing.pdf

Country Examples
Different emphases and effort

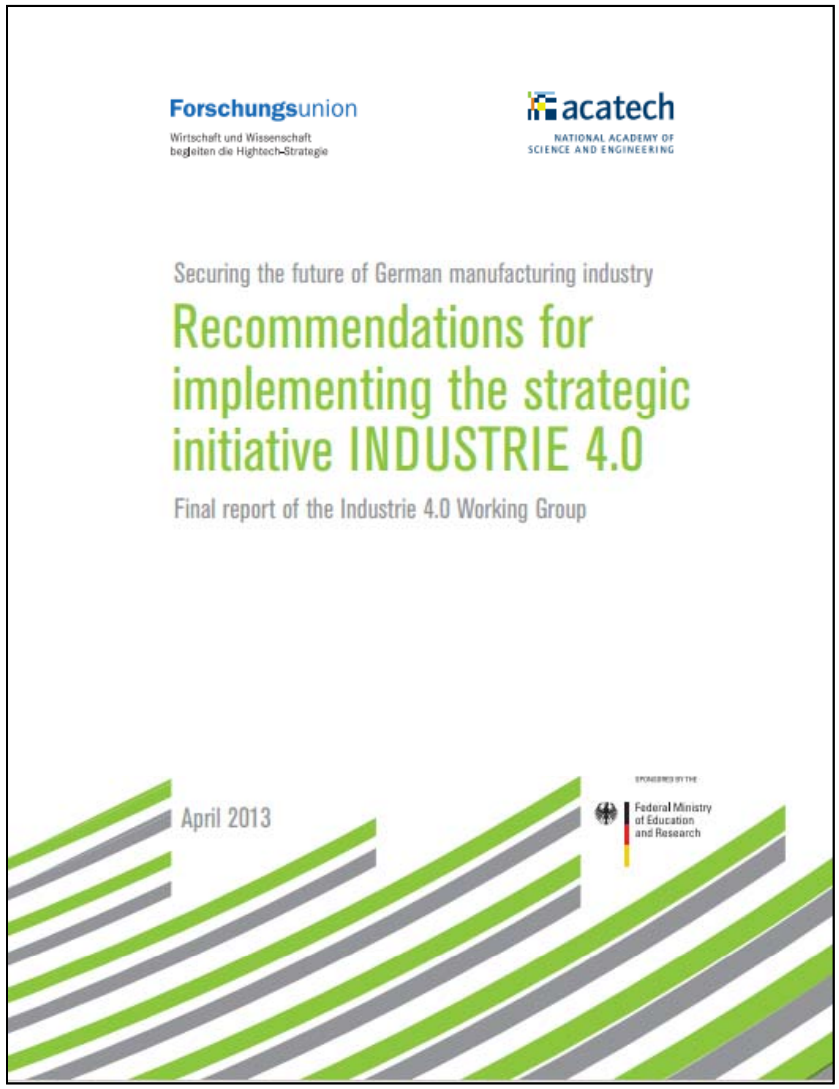
- Germany
- United States
- Japan

Digitalisation of Manufacturing: Germany

Smart factories, smart supply chains

Digitalisation of Manufacturing: Germany

Strategic Initiative: **Industry 4.0**



Coordinating Ministries

Federal Ministry of Education and Research, Federal Ministry of Economics & Technology

Federal Ministry of Education and Research

Federal Ministry for Economic Affairs and Energy

€200 million available for "Industry 4.0" project

Digitalisation of Manufacturing: Germany

Leading Edge Cluster for INDUSTRIE 4.0

Das Technologie-Netzwerk:
Intelligente Technische Systeme
OstWestfalenLippe

it's owl

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Source: It's owl (2015). On the road to Industry 4.0: Solutions from the Leading-Edge Cluster it's OWL http://www.its-owl.com/fileadmin/PDF/Informationsmaterialien/2015-On_the_road_to_Industry_4.0_-_Solutions_from_the_Leading-Edge_Cluster_it_s_OWL.pdf

Digitalisation of Manufacturing: Germany

Leading Edge Cluster for INDUSTRIE 4.0

Das Technologie-Netzwerk:
Intelligente Technische Systeme
OstWestfalenLippe

it's owl

Intelligent Technical Systems OstWestfalenLippe

- 'Leading-Edge Cluster' alliance of 174 businesses, universities and institutes
- €100m in 5 years / €40m founding
- 46 research projects to develop intelligent technical systems - **make Industry 4.0 a reality**

Major focus on strengthening SMEs

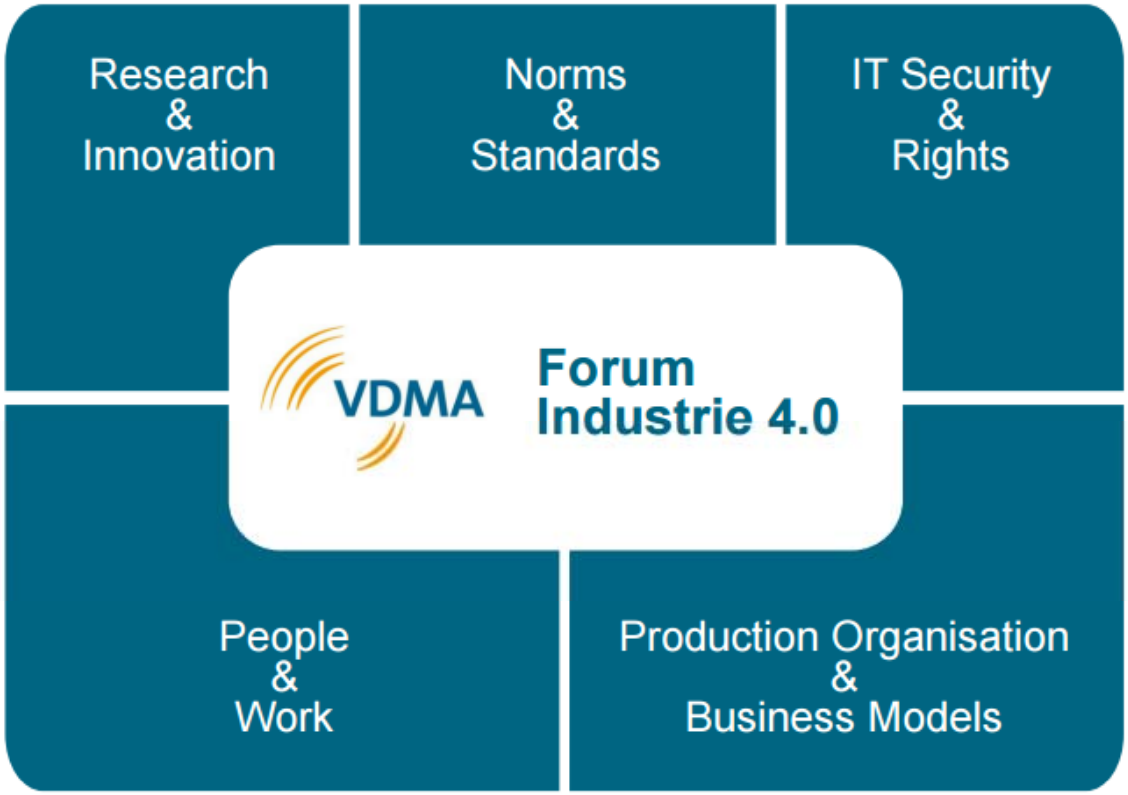
- **Technology platform** serves as basis for dissemination, with transfer projects making technologies and methods developed by the cluster available to SMEs, in particular
- **Seven industry support initiatives:** Strategic foresight, education/training, internationalisation, start-ups, market orientation, acceptance, prevention of piracy

www.its-owl.com/

Digitalisation of Manufacturing: Germany

Not just a technology R&D challenge

Skills & training, infrastructure, standards, SME upgrading (manufacturing advisory services), security & rights...



Source: VDMA (2015). *Industrie 4.0 – From Vision To Reality*
www.smartindustry.nl/wp-content/uploads/2015/01/2.1-internationaal-Industry_4.0_Master_Forum_i40_SmartIndustryLaunch22January.pdf

Digitalisation of Manufacturing

United States

The country that gets new products to market faster and at less cost will win the race for the good jobs of tomorrow.

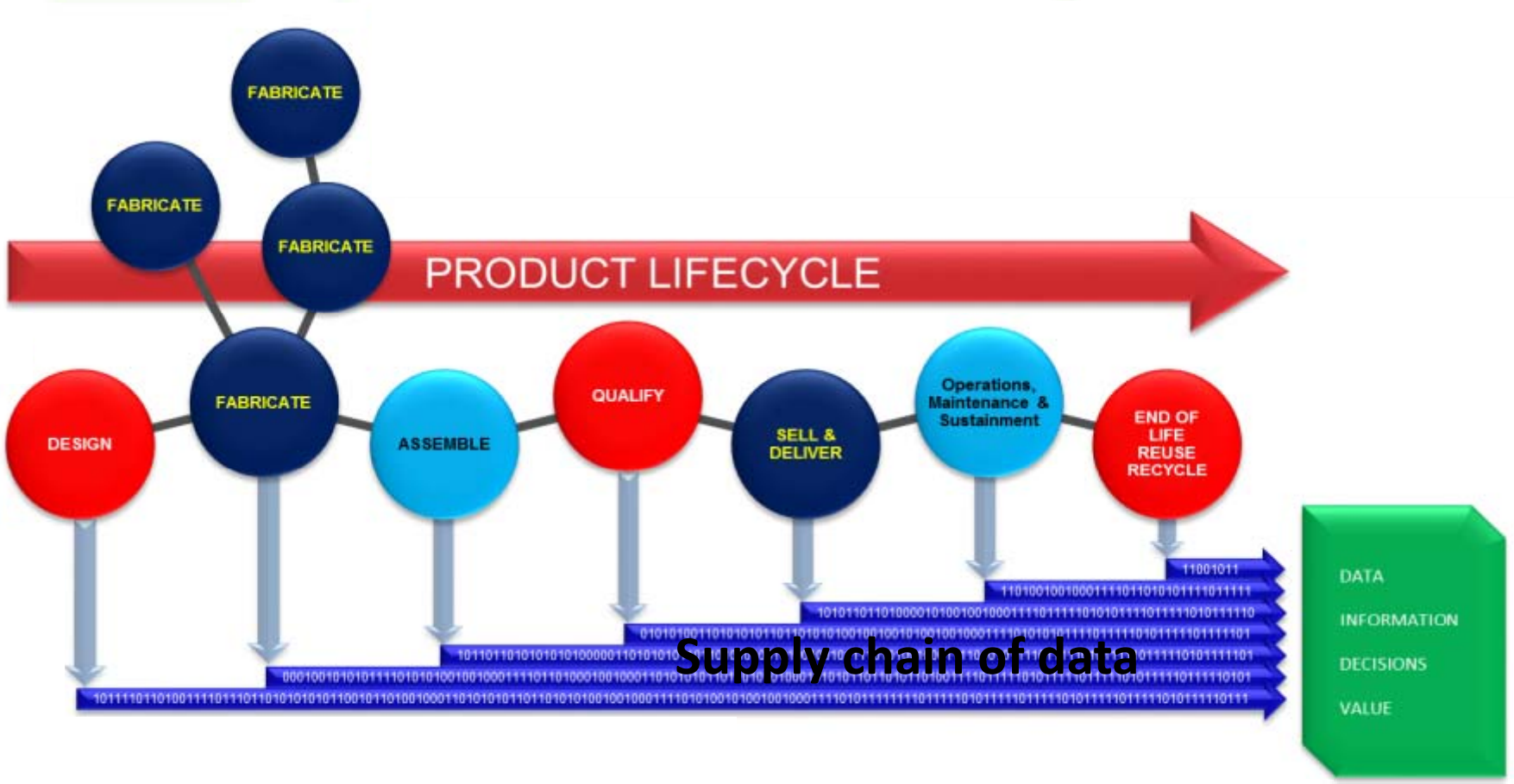
... want suppliers to be able to collaborate with customers in real-time, test parts digitally, cut down on time/money spent on prototypes...

... want manufacturers to be able to custom-design products tailored to individual consumers..

... want our troops to be able to download digital blueprints to 3-D print new parts and repair equipment right there in the field...

Digitalisation of Manufacturing: United States

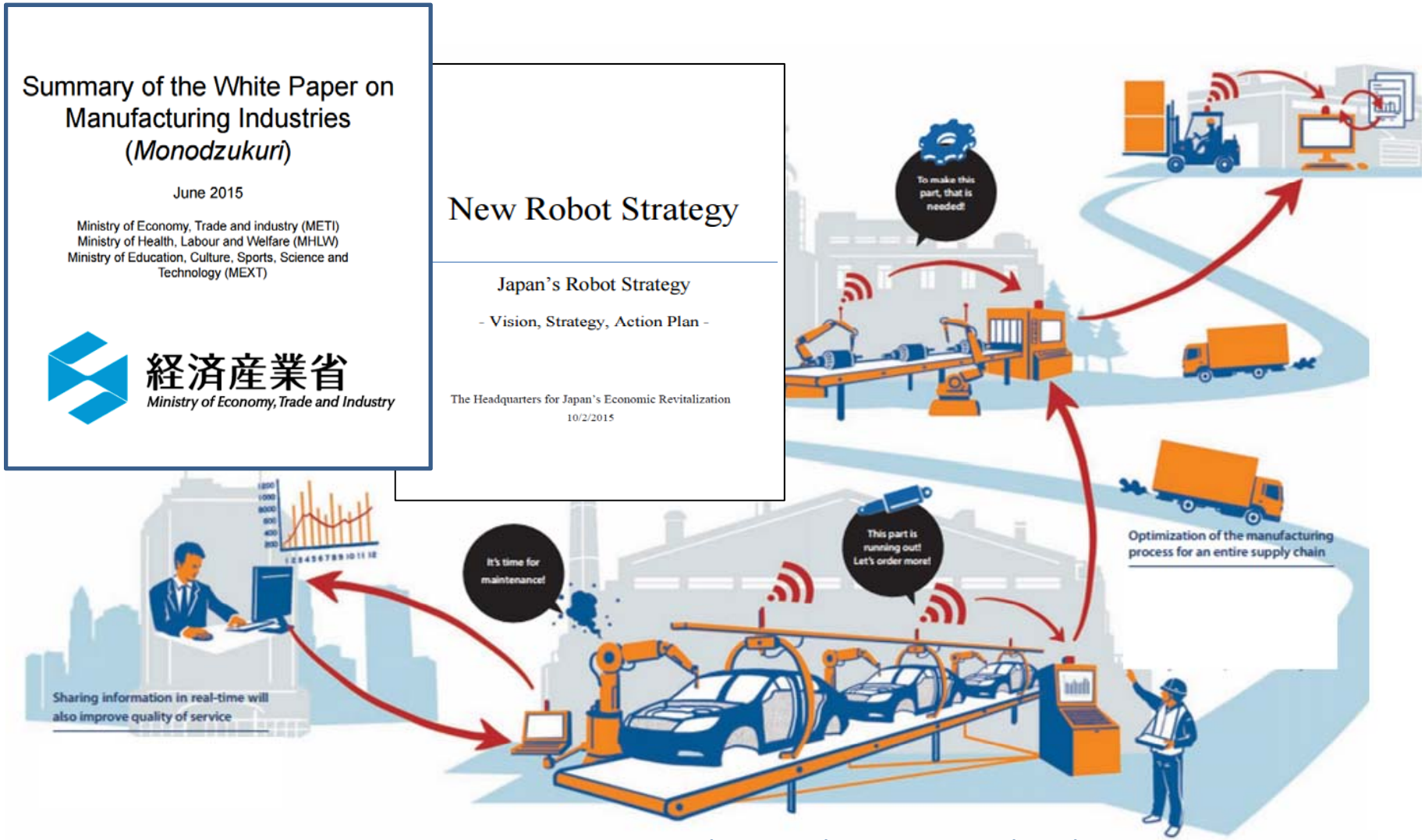
The 'Digital Thread'



Source: Harris, G. (2015). *Digital Manufacturing and Design Innovation Institute*
www.ndia.org/Divisions/Divisions/Manufacturing/Documents/619A%20Presentations/7.DMDII%20Status%2020151022.pdf

Digitalisation of Manufacturing

Japan



Source: *METI Journal* (May 2015): www.meti.go.jp/english/publications/pdf/journal2015_05a.pdf

Digitalisation of Manufacturing

Japan

Summary of the White Paper on Manufacturing Industries (*Monodzukuri*)

経済産業省
Ministry of Economy, Trade and Industry

Strategies in Europe and the United States

United States: Cloud computing (e.g. Google)

Getting value through use of Big Data

Germany: Industry 4.0 (e.g. Siemens)

Leading standardisation for connecting production machines

Japan: Advanced Robotics

Japan Strategies – Leading the world with robots in the IoT era:

1. **Winning the race for global standards** for common infrastructure (e.g. operating systems) for **robots in manufacturing sites**, where Japan has advantages
2. **Utilizing robots and accumulating data (for Big Data) as a front-runner** in various fields e.g. infrastructure (e.g. data on deterioration over time)
3. **Strengthening artificial intelligence (AI)** technology that creates **wealth from accumulated data.**

Digitalisation of Manufacturing: Japan

Three pillars of the Robot Revolution:

1. **Becoming a global base for robot innovation**
2. **The society with the best and most proactive use of robots**
   (e.g. SMEs, agriculture, nursing/medical care, infrastructure)
3. **Leading the world with robots in the *Internet of Things* era**
   (Making robots able to use big data, networks, and AI)

Robot Revolution Initiative
ロボット革命イニシアティブ協議会

rri

www.jmfrri.gr.jp/english

Digitalisation of Manufacturing

Concluding comments: "It's not just about..."

What is it? Digitalisation happening in different dimensions:

- V**ertically** within ever "smarter" factories / manufacturing firms
- **Horizontally** within ever more connected "smart" supply chains / "ecosystems" of enterprises
- **Along "digital thread"** throughout lifecycle of products/services

What are the value capture opportunities?

- Potential *user value* from greater **efficiency, flexibility, speed/responsiveness, precision, customisation**
- Manufacture of key technology elements (**embedded systems, robots**, etc...)
- Knowledge management / data analysis via ***Internet of Things AND Services;***
- Building the **infrastructure** (sensors, batteries, broadband...)

What are the challenges to competing in 'Industry 4.0'?

- Digital manufacturing **technology R&D**
- Also... **standards, skills / workforce development, infrastructure, SME capacity building, security** / rights (transparency/trust)...

IfM MANAGEMENT TECHNOLOGY POLICY

Thank You

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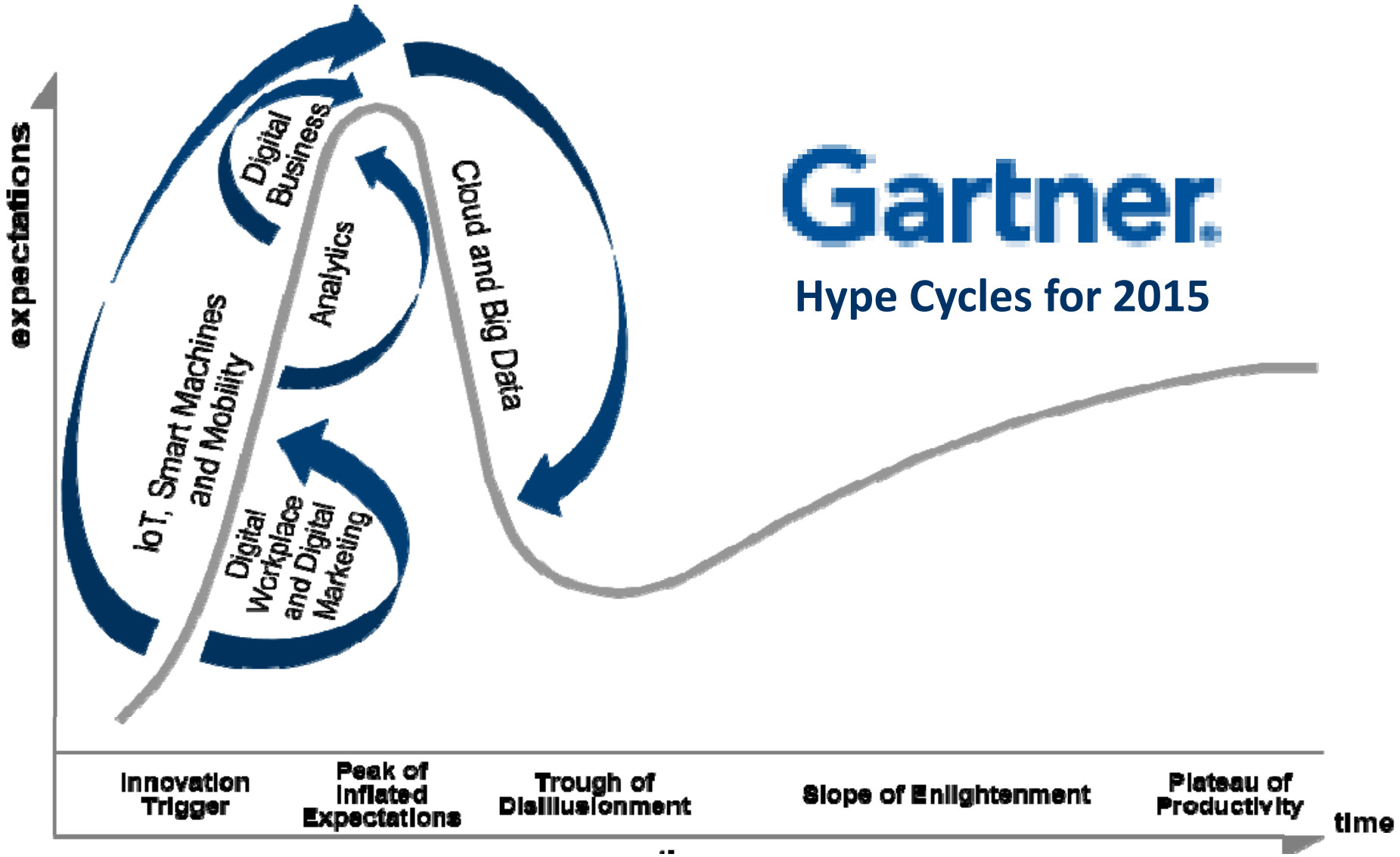
CSTI Science Technology Innovation Policy

Digitalisation of Manufacturing

Hype?



Digitalisation of Manufacturing

Trends & Drivers

Customer demands

- Customer demand for product variety
- Personalised products / services
- Faster response to needs
- Added-value services (social media interaction, order status tracking)
- Societal and economic pressure to increase sustainability

User industry pressures

- Increasing need for asset and resource efficiency
- Growing reliance on supply chain and need for robustness and tracking
- Increasing security risks
- Shorter product lifecycles
- Value-added services throughout product life-cycle
- Increasing complexity: Products, production, data...

US Advanced Manufacturing Policy

Priority Manufacturing Technology Areas

Prioritisation based on:

- Industry and/or market pull
- Cross-cutting impact on sectors
- US security or competitiveness
- Leveraging US strengths

Technology Priorities

1. Advanced Materials Design, Synthesis, & Processing
2. **Advanced Sensing, Measurement, & Process Control** (ASMPC)
3. **Visualization, Informatics, & Digital Manufacturing** (VIDM)

US Advanced Manufacturing Policy

Digital Manufacturing & Design Innovation Institute

Lead organisation: UI LABS
HQ: Chicago, Illinois
Members: 190 companies, Universities and Labs, and other organizations
Funding: $320M ($70M Federal)

Mission:
Establish a state-of-the-art proving ground for digital manufacturing and design that links IT tools, standards, models, sensors, controls, practices and skills, and transitions these tools to the U.S. design & manufacturing industrial base for full-scale application.

TECHNOLOGY THRUST AREAS

- **Advanced Analysis:** The collection of data over long periods of time to enable manufacturing design that takes future possibilities into consideration.
- **Intelligent Machining**: Integrates smart sensors and controls to enable equipment to automatically sense and understand current production environment in order to conduct self-aware manufacturing.
- **Advanced Manufacturing Enterprise**: Aggregates / integrates data throughout manufacturing supply chain product life-cycle