Global Trends in the Digitalisation of Manufacturing
Definitions, priorities & policies

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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?
“What makes some national innovation systems more effective than others at translating science & engineering research knowledge into new technologies, industries & economic wealth?”
International Benchmarking
Foresight, Policy Trends & R&D Prioritisation
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
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**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.

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**Gartner:**

26 billion devices that connect to the Internet by 2020

**Cisco:**

50 billion devices connected IoT by 2020

**IDC:**

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

“**Big data is like teenage sex:**
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
  - Cyber physical 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
  - Model based everything
  - Embedded software/sensors
  - Industrial internet

- **Organising sharing and analysing data**
  - Connectivity, data gathering, control

- **Sensing and interacting with material world**

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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*
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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.
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Where’s the value?

Drivers of manufacturing competitiveness
- Efficiency
- Quality
- Price
- Flexibility / agility
- Speed of response
- Reduction in defects
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- Speed of NPD

Source:
Country Examples
Different emphases and effort
• Germany
• United States
• Japan
Digitalisation of Manufacturing: Germany
Smart factories, smart supply chains

“Connecting digital technologies with industrial products and logistics
- Industry 4.0 -
Germany has a chance at taking the lead”
Digitalisation of Manufacturing: Germany

Strategic Initiative: **Industry 4.0**

**Coordinating Ministries**
Federal Ministry of Education and Research, Federal Ministry of Economics & Technology

€200 million available for "Industry 4.0" project
Digitalisation of Manufacturing: Germany
Leading Edge Cluster for INDUSTRIE 4.0

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

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*
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’

Digitalisation of Manufacturing

Japan

Digitalisation of Manufacturing
Japan

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

[www.jmfrri.gr.jp/english]
Digitalisation of Manufacturing

Concluding comments: “It’s not just about...”

What is it? Digitalisation happening in different dimensions:
• **Vertically** 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)...
Thank You

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Digitalisation of Manufacturing

Hype?

Gartner

Hype Cycles for 2015
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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