Factories of the future?
The ‘Factories of the Future’ PPP (public-private partnership) was launched in 2008 with a budget of €1.2 billion (Framework programme 7)

✓ To develop technologies, systems and processes to change our conception of manufacturing and even the factory itself,

✓ from highly networked manufacturing to localized production to re-manufacturing services

✓ Research challenges
  • Sustainable manufacturing
    – Environmental friendliness, Economic growth, Social well-being
  • High performance manufacturing
    – Flexible adaptive production equipment, systems and plants for rapid (re)configurations and optimal energy use
    – High precision micro-manufacturing machines and systems
    – Tools for production planning and in-situ simulation for open reconfigurable and adaptive manufacturing systems
  • Exploiting new materials through manufacturing
  • ICT-enabled intelligent manufacturing

* EFFRA (European Factories of the Future Association): a MANUFUTURE initiative
Factories of the Future: ICT Vision

**Smart Factories:**
- **Goal:** More automation, better control & optimisation of factory processes
- **Means:** Software, lasers & intelligent devices embedded in machines & factory infrastructure

**Virtual Factories:**
- **Goal:** To manage supply chains; to create value by integrating products & services
- **Means:** Software to holistically interconnect & manage distributed factory assets; new business models & value propositions

**Digital Factories:**
- **Goal:** To “see” the product before it is produced
- **Means:** Software for the digital representation & test of products & processes prior to their manufacture & use

**Factory productivity**
- Less waste
- Less energy use
- Faster time-to-market
- Better quality

**Supply-chain productivity**
- High-value products
- Keep jobs in Europe
- Process transparency
- IPR security
- Lower CO₂ footprint

**Design productivity**
- Reduce design errors
- Better & efficient products
- Less waste + rework
- Faster time-to-market
Factories of the Future PPP FoF 2020 Roadmap (Dec. 2012)

- The long term direction:
  - Factory and Nature → green / sustainable
  - Factory as a good neighbour → close to the customer
  - Factories in the value chain → collaborative (highly competitive products, IPPS)
  - Factory and Humans → human centred

- Research challenges
  - Manufacturing the products of the future
  - Economic sustainability of manufacturing
    - Reconfigurable, flexible, adaptive, small scale production, zero-defect, resource efficient, end-of-lifecycle
  - Social sustainability of manufacturing
    - Human, attractive workplace, workers
  - Environmental sustainability of manufacturing
    - Energy, pollution, new materials
FoF – Research & innovation priorities

- **Domain 1: Advanced Manufacturing processes**
  ✓ Innovative processing for both new and current materials or products
- **Domain 2: Adaptive and smart manufacturing systems**
  ✓ Innovative manufacturing equipment at component and system level, including mechatronics, control and monitoring systems
- **Domain 3: Digital, virtual and resource-efficient factories**
  ✓ Factory design, data collection and management, operation and planning, from real-time to long term optimisation approaches
- **Domain 4: Collaborative and mobile enterprises**
  ✓ Networked factories and dynamic supply chains
- **Domain 5: Human-centric manufacturing**
  ✓ Enhancing the role of people in factories
- **Domain 6: Customer-focused manufacturing**
  ✓ Involving customers in manufacturing value chain, from product-process design to manufacturing associated innovative services
FP7 Calls

II.5.1 'Factories of the Future' Public-Private Partnership (FoF) - Cross-thematic Coordination between NMP and ICT

II.5.1.1 'Factories of the Future (FoF)' - Public-Private Partnership

- FoF.NMP.2013-1 Improved use of renewable resources at factory level
- FoF.NMP.2013-2 Innovative re-use of modular equipment based on integrated factory design
- FoF.NMP.2013-3 Workplaces of the future: the new people-centred production site
- FoF.NMP.2013-4 Innovative methodologies addressing social sustainability in manufacturing
- FoF.NMP.2013-5 Innovative design of personalised product-services and of their production processes based on collaborative environments
- FoF.NMP.2013-6 Mini-factories for customised products using local flexible production
- FoF.NMP.2013-7 New hybrid production systems in advanced factory environments based on new human-robot interactive cooperation
- FoF.NMP.2013-8 Innovative strategies for renovation and repair in manufacturing systems
- FoF.NMP.2013-9 Advanced concepts for technology-based business approaches addressing product-services and their manufacturing in globalised markets
- FoF.NMP.2013-10 Manufacturing processes for products made of composites or engineered metallic materials
- FoF.NMP.2013-11 Manufacturing of highly miniaturised components

ICT for the Enterprise and Manufacturing

- FoF: Application experiments for robotics and Simulation
- FoF: Equipment assessment for sensor and laser based applications
미래제조시스템 키워드

- Smart
- Green
- Human
- Personalized, Workers, Elderly
- ICT, Connected, Decentralized, Reconfigurable
- Renewable, Reuse, Reduce
Industrie 4.0

- German high-tech strategy 2020 action plan – 10 Future Projects (3. 2012)
- From Jan. to Oct. 2012 (Working Group on Industry 4.0): 10 ~ 15 year time frame, EUR 200 million
- 4th Industrial Revolution?
  - Technological evolution from embedded systems to cyber-physical systems
  - From “centralized” to “decentralized” production
  - The parts know what they are
- Connected (Networked) : IoT, IoE, CPS
- By connecting machines, work pieces and systems, we are creating intelligent networks along the entire value chain that can control each other autonomously

Self-Organizing Factories

As information generated in the virtual world flows into real manufacturing processes, completely new production environments will emerge. In smart factories, communities of machines will organize themselves, supply chains will automatically coordinate with...
THE EVOLUTION OF EMBEDDED SYSTEMS INTO THE INTERNET OF THINGS, DATA AND SERVICES

Vision: Internet of Things, Data and Services
e.g. Smart City

Cyber-Physical Systems
e.g. intelligent networked road junction

Networked Embedded Systems
e.g. autonomous aviation

Embedded Systems
e.g. airbag

Source: Acatech 2011
Industry 4.0

- Vision:
  - **individualization** (batch sizes of 1) at mass production prices
  - manufacturing will be highly **flexible**, extremely **productive** (up to +50%), will use **fewer resources** (up to -50%) and will be compatible with an urban environment
  - **dynamic design** of business and engineering processes
  - **work-life balance** taking account of availability of individual workers
  - **older employees** supported by smart assistance systems
  - existing infrastructure can be **upgraded gradually**

http://www.plattform-i40.de
“Toward that concept of a connected world, where all of your devices are rolling up data, but you’re slicing it. It’s not the thousands of pieces of data; you’re slicing it in such a way that it is presented to the right user at the right time based on their role.”

“To me,” he says, “that’s the smart factory of the future.”

Jeff Immelt, CEO, General Electric
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**WG 1: Smart Factory**
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**WG 5: Technology Factor**
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- Bitkom, TU München,
- Universität Oldenburg,
- Universität Bremen
Opportunities by industry 4.0

- Flexible manufacturing: transparent process, respond quickly to change
- Individual production: quickly react to individual customer-specific requirements, Complicated reprogramming is not necessary
- Innovative business models: new services, big data
- New jobs

- High competitive strength: leading international supplier in the area of embedded systems (Germany will become a leading supplier for 2020 "Cyber-Physical Production Systems")
Industrie 4.0

✓ Dual Strategy & Key Features:
  • Becoming a leading supplier: equipment supplier industry,
  • Becoming a leading market: German domestic manufacturing industry

  • Horizontal Integration (Inter-company value chain)
  • Digital end-to-end engineering (Lifecycle)
  • Vertical integration (Networked mfg.)

by CPS
Beckhoff implements open automation systems based on PC Control technology. The product range covers Industrial PCs, IO and Fieldbus Components, Drive Technology and automation software. Products that can be used as separate components or integrated into a complete and seamless control system are available for all industries. The Beckhoff "New Automation Technology" philosophy represents universal and open control and automation solutions that are used worldwide in a wide variety of different applications, ranging from CNC-controlled machine tools to intelligent building automation.

Beckhoff Automation
Factories of the future?
Smart?
 미래제조시스템 키워드

ICT, Connected, Decentralized, Reconfigurable

Smart Human

Personalized, Workers, Elderly

Renewable, Reuse, Reduce
Modular design & Mini-factories
Mini-factories for customised products using local flexible production

- needed to enable *ultra-fast and cost-effective manufacturing of fully customised products on the spot and exactly at the required time*
- manufacturing operations closer in time and space to the final customer
- Those mini-factories, addressing adaptation to customer needs at or near the point of sales or use, will be characterised by *fast ramp-up, small footprint and reusability*, and will be *easy to handle and to set-up*. 
Modular Design

- Component-sharing modularity
- Component-swapping modularity (different options, e.g. power/manual door locks and window of cars)
- Cut-to-fit modularity (parameters or features can be adjusted)
- Platform modularity

Benefits of late Point of Product Differentiation

- Easier to control
- Faster reaction to customer requirement
- Lower inventory costs
- Fewer interfaces
Voice of Workers
제조산업 키워드의 변화

- 통합화
- CIM
- 자동화
- 공정혁신
- 원가절감
- 무인화
- 납기단축
- 과거/현재
- 기계중심 (인간 소외, 생산성 중심)
- 미래
- 기술중심 (기술력, 디자인, 제품, 생산)
- 인간중심 (인간친화, 생산성 중)
- 한국형 미래제조시스템 융합/원천/시스템 기술

Manufacturing Keywords

- 통합화
- CIM
- 자동화
- 공정혁신
- 원가절감
- 무인화
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- 한국형 미래제조시스템 융합/원천/시스템 기술

제조업에 대한 인식 변화 ➔ 창조적 미래경제 주도

- 캠판혁신 (0ppm)
- 생산성향상
- 원가절감
- 납기단축
- 공정혁신
- 6 Sigma
- 원가절감
- 무인화
- 납기단축
- 과거/현재
- 기계중심 (인간 소외, 생산성 중심)
- 미래
- 기술중심 (기술력, 디자인, 제품, 생산)
- 인간중심 (인간친화, 생산성 중)
- 한국형 미래제조시스템 융합/원천/시스템 기술

친환경 = Green (Eco-friendly)
지속가능 (Sustainable)

ICT 기반 (Cloud, Big data)
Smart MES

“The parts know what they are”
**MES 3-Layers**

**1st layer: Resources & Drivers**
- Material handler, Actuator, Sensor, ...

**2nd layer: Control Channel**
- Industrial PC, PLC, Embedded controller, Smart controller, Bus terminal, Relay, ...

**3rd layer: Monitoring & Management**
- Fault resolution
- Operation monitoring
- Performance analysis
- Quality management
- etc.

**Inter-Comm. Interface**
- Ethernet (IEEE 802.3)
- Wireless (IEEE 802.11)
- Legacy comm. Protocols: RS422, RS485
- OPC-UA
- Agent language (KIF)

**Intra-Comm. Interface**
- RFID, NFC
- Legacy comm. Protocols: RS232C
**Shop floor control level**의 기존 레퍼런스 모델 표준

**ISO/TR-10314: Industrial automation – shop floor production**
- PART I: Reference model for standardization and a methodology for identification of requirements, 1990
- PART II: Application of the reference model for standardization and methodology, 1991
Design from Failure & Design for Traceability

설계-서비스 Inter-loop 정보 통합: 제품 재설계를 위한 운용(사용) 정보

설계

제조(시공)

서비스

설계 Intra-loop 정보: 최적/ 신속 (재)설계

설계-제조 Inter-loop 정보 통합: Design for manufacture/assembly

제조 Intra-loop 정보: 공정 모니터링 및 예지보전, 스마트 MES

제조-서비스 Inter-loop 정보 통합: 공정재설계 및 검사시스템 개선

제품 운용 및 품질 문제 정보

서비스 Intra-loop 정보: 원격진단 및 유지관리, Operation Intelligence

공정 1 → 공정 2 → 공정 n

생산이력 및 품질검사 정보