The future of manufacturing is with smart factory (Industry 4.0)

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2015. 12. 09.
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- Ph.D. Industrial Eng., Yonsei Univ. (2006)
- Six Sigma MBBc (2006 ~ now)

Research Field

- Production Management.(FOPIS)
  - MES, Process Simulation, Quality
  - Manufacturing Assessment
- Smart Factory
Human-being

Customer

Workers
OEM
Brand

Vision

Safety / Salary / Welfare
Productivity / Prod. Management / Due Date / Margin
R&D / Supply Chain Management / Margin

Target

Smart Factory

Concept

Digital Manufacturing
Virtual Manufacturing
Smart Manufacturing
Intelligent Manufacturing
FMS / CIM / IMS

Philosophy

End-to-End Engineering
PLM
Connected Factory
DFSS (Design for Six Sigma)
Integration

ICT Technology

IoT, Cloud, Big data, 3D printer, VR/AR, Energy, Smart Sensor, etc.

Factory/Plant
Contents

I. Strategies and status of the CSF project
   1. Strategies
   2. Status
   3. Vision

II. Case studies of a smart factory and Industry 4.0
   1. Overseas case studies
   2. Domestic case studies
I. Strategies and status of the CSF project

1. Strategies
2. Status
3. Vision and benefits
1.1 Introduction of the CSF testbed

What is the Testbed?

[Testbed ?]
1. Experimental factory for validation of CSF core technology
2. Bridges connecting the supply industry and demand industry

[Testbed project ?]
1. Lab rental service that can be used by all users
2. Project to support the certification and commercialization of core technologies
[Reference] Core technologies of CSF

1. Strategies

“8 smart manufacturing technology”
(End-to-End Engineering)
1.2 Establishment strategies for T/B

Keywords: S.M.A.R.T.

- Supplier
- Total
- Model
- Open
- Replaceable
- Approved
1.3 Detail contents

**Phased testbed type**

1. **1st Testbed (Gumi)**
   - Assembly line for precision motor
   - Mass production
   - Mass Customization
   - Business-to-Business

2. **2nd Testbed (Ulsan)**
   - Assembly line for medical equipment
   - Mass Customization
   - Personalization
   - Business-to-Customer

3. **3rd Testbed (Cheonan)**
   - Model Factory
   - Personalization
   - Business-to-Business / Customer
1.4 Application technologies

Integration of CSF core technologies based ISA-95 standard framework

- FaaS Platform
  - Inter-Factory platform
  - CPPS
  - CPPS Platform
  - Virtual testbed
  - Open process simulator

- Smart Work Cap
  - FaaS validation
  - Open MES (Manufacturing Execution System)
    - Quality predictive tech.
    - Reconfigurable tech.

- Industrial IoT
  - Open Device, Control technology

- Testbed H/W

Level 4
- Business Planning & Logistics
  - Plant Product Scheduling, Operational Management etc.

Level 3
- Manufacturing Operation Management
  - Dispatching Production, Detailed Production Scheduling, Production Tracking etc.

Level 2
- Batch Control
- Continuous Control
- Discret Control

Level 1
- I/O Devices, Sensors
- AMS/ISA85 Framework
- ERP, APO, Logistics Sys.
- Business Process Info. Networks
- MES (Manufacturing Execution Sys.), LIMS (Lab, Inf, Manage, Sys.), WMS (Warehouse Manage Sys.)
- Operation Info. Networks
- MML, SCADA, Batch Systems
- Automation Networks
- PLC, DCS, Fieldbus Systems
- Discrete & Process Comm. Networks

Locations:
- Gumi
- Ulsan
- Cheonan
2.1 Core technology

Establishment of HW infra for open CSF testbed (1st T/B)

CSF AS-IS Supply Technology

1. Testbed H/W tech.
2. Device and control tech.
3. Industrial IoT tech. (sensor & communication)

Precision Motor
2.1 Core technology

Establishment of the architecture and API of control and comm. I/F for standardization and expansion

Inter communication (factory to factory)

Intra communication (In-factory)
2.1 Core technology

Implementation of the open MES for production control and process management
2.1 Core technology

Implementation of the open process simulator for process and layout validation

Process Simulator

Decision making system
2.1 Core technology

Establishment of a testbed

- Establishment of a CSF testbed Through the connection of real factory and virtual factory
- Establishment of a hybrid smart factory testbed

Virtual Factory

- Establishment of a Virtual testbed
  - VR model
  - Feasibility study

Hybrid Factory

- Establishment of a hybrid testbed between virtual and real factory
  - Validation of the expansion and feasibility of a smart factory

Real Factory

- Real Testbed
  - Real Model
  - Review of the real factory interoperability
2.2 Biz Model

Development of certification system and application for CSF

- 기능성 평가
- 성능 및 신뢰성 평가
- 상호호환성 평가
- IT보안 평가

Comprehensive Certification Program

Modular Certification Program

Transport Layer Testing (기존 자율인증 프로그램과 연계)
3.1 Starting point of smart factory

Our goal?

Supply Industry

Demand Industry

Application into real factory

Manufacturing Innovation 3.0

Korean-style Smart Factory

Supply Industry TB
Model factory for assembly product
(‘15 ~ ‘18)

✓ How do we create a smart factory? If we use a global supplier technology...

✓ Development of competitive domestic enterprises with CSF core technology
Core Technology of Smart Factory

From *Follower* to *Creator*
3.2 We?

Human Factory

CSF Coalition

www.humanfactory.org

Exhibition

Forum

Solution (H/W, S/W)

Model Factory

SF Analysis Report

SF Coalition

Consulting/Edu.

8 Smart Manufacturing Tech.

Gumi, Korea

Ulsan, Korea

KITECH/UNIST Ver 0.1

Textile Industry Model Factory

Virtual Smart Factory

Supply Company (LG Innotek, LGU+, Duzon, Autonics, Hansol NexG etc)

Demand Company (Samsung Electro-mechanics, Hyosung Power & Industrial Systems,)

Consulting Firm, University
3.2 We?

Korean-style CSF (Connected Smart Factory) strategy

1. Equipment & Solution Provider
2. Supply Industry
3. Demand Industry
4. OEM Production
5. Mass Production
6. Mass Customization
7. Factory Maker

Development stage of the manufacturing enterprise
Case studies of a smart factory and Industry 4.0

1. Overseas case studies
2. Domestic case studies
1.1 Status of smart factory supply industry

Global supply company

- ABB
- APRISO
- DASSAULT SYSTEMES
- EMERSON
- freescale

- GENERAL DYNAMICS
- GE
- Honeywell

- Intel
- Invensys
- Johnson Controls
- Microsoft
- Mitsubishi Electric

- NATIONAL INSTRUMENTS
- Rockwell Automation
- Schneider Electric
- Siemens

- VIMANA
- TELEDYNE TECHNOLOGIES
- Ubisense

(Source: MarketsandMarkets, 2013)
1.1 Status of smart factory supply industry

(Source: MarketsandMarkets, 2013)
1.2 Germany - DFKI

Smart Factory Platform (1st)

- **continuous flow process**
  - colored soap production

- **discrete handling process**
  - bottling, handling, labeling, QC, packaging...

Live-Webcam: http://www.smartfactory.de/webcam.de.htm
1.2 Germany - DFKI

Smart Factory Platform (1st)

assembly process
Key finder production

augmented reality
Information, maintenance and control
1.2 Germany - DFKI

Smart Factory Platform (2\textsuperscript{nd}, '14 ~)

**SmartFactory\textsuperscript{KL} Infrastructure Backbone**

- **Infrastructure Switch**
  - smartFactory\textsuperscript{KL}

**Manual Workstation**

- MiniTec
- augmented reality-based manual assembly guidance
- workflow recognition system

**Quality Control**

- LAPP KABEL
- visual quality control with high-resolution camera
- commissioning

**Laser Marking**

- PHOENIX CONTACT
- laser marking of casing cover
- individual QR-code and lettering

**Assembly**

- Rexroth Bosch Group
- force fitting casing cover and bottom
- casing cover magazine

**Engraving**

- FESTO
- individual engraving of casing bottom
- casing bottom magazine

**Coordination and Infrastructure**

- smartFactory\textsuperscript{KL}
- manufacturing backbone technology
- integration and overall implementation

**Connected Security**

- HIRSCHMANN + BETZOLD
- distributed security solution for the manufacturing backbone
- multiple-port firewalls and greater link speeds

**Power Measurement**

- complete transparency of energy flows and energy consumption
- use of existing ethernet structures

**Connected Factory**

- video-based remote maintenance
- video recording and conferencing

**ERP Solution**

- PROALPHA
- central order entry and management system
- materials management and cross-module functions

**Product Lifecycle Management**

- SIEMENS
- single system of record to support diverse data needs
- access to a common repository of product information and processes

**KITECH**
1.2 Germany - DFKI

<table>
<thead>
<tr>
<th>Participating companies</th>
<th>Applied Technology</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>CISCO</td>
<td>CISCO provides a complete and unique breadth of infrastructure including wired and wireless routing and switching.</td>
<td>Connected Factory</td>
</tr>
<tr>
<td>FESTO</td>
<td>Festo joined the manufacturer independent technology initiative SmartFactory KL e.V. in 2013.</td>
<td>Module Engraving</td>
</tr>
<tr>
<td>HARTING</td>
<td>Harting provides the interoperability between different automation modules</td>
<td>Module Force Fitting</td>
</tr>
<tr>
<td>HIRSCHMANN</td>
<td>HIRSCHMANN and LUMBERG AUTOMATION as the world leading manufacturers of innovative security technologies for distribution and processing of industrial communication ensure the reliable operation of the SmartFactoryKL -Demonstrator.</td>
<td>Connected Security</td>
</tr>
<tr>
<td>LAPPKABEL</td>
<td>As a solution provider of cabling and connecting systems for industrial automation technologies</td>
<td>Module Quality Control</td>
</tr>
<tr>
<td>MINITEC</td>
<td>The Manual Workstation is a height-adjustable, ergonomically designed system workplace consisting of MiniTec aluminum profiles.</td>
<td>Manual Workstation</td>
</tr>
<tr>
<td>PHOENIX CONTACT</td>
<td>The Rexroth module Clip Mounting reads the product memory via RFID</td>
<td>Module Laser Marking</td>
</tr>
<tr>
<td>PROALPHA</td>
<td>ERP system</td>
<td>ERP System</td>
</tr>
<tr>
<td>REXROTH</td>
<td>RFID를 통한 제품 메모리 read</td>
<td>Module Clip Mounting</td>
</tr>
<tr>
<td>SIEMENS</td>
<td>PLM system</td>
<td>Product Lifecycle Management</td>
</tr>
</tbody>
</table>
1.2 Japan – MITSUBISHI ELECTRIC

Establishment of a model factory using own controller, device, and robot technology
2.1 Development of supply industry

CSF Testbed Ver 0.1 (KITECH & UNIST) (http://sf.unist.ac.kr/)

- Transfer Module
- Assembly Module
- IoT & Sensor Tech.
- Control & device Tech.
- System Integration

Equipment Provider

Manual Transmission for car

Solution Provider

MES
Energy Optimization
IoT
CPPS
Data Mining
2.1 Development of supply industry

CSF Testbed Ver 0.1

New industry (New service) → Export of smart factory model (Plant) → Promotion of SMEs


MES (Manufacturing Execution System)

Manuf. IoT Platform  Energy Platform

Test-Bed Platform
2.1 Development of supply industry

CSF Testbed Ver 0.1 (KITECH & UNIST) : CPPS

Cyber Factory (Factory 3D Model)  
Physical Factory

MES DB  
(Man, Method, Material, Machine, Energy)

MES

KITECH
2.1 Development of supply industry

CSF Testbed Ver 0.1 (KITECH & UNIST) : VR technology
2.2 Development of demand industry

Smart of a textile industry

Issue: integration of process data and energy data (velocity)
Thank you !!