Standard-based Global Operation by a World Leading Manufacturer

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Profile – BG(Byung Gon) Lee

Key Areas of Expertise

- MES Product Development/Business Consulting
- Solution and Enterprise Architecture of Smart Factory
- Manufacturing Enterprise IT Systems implementation
- World 1st 300mm MES and Global MES project manager

Key Work Experiences

- Involving Next Generation MES

SAMSUNG SDS, Miracom CEO (2009 ~ 2019)
- Vice President, Smart Factory Business Division

Applied Materials (2007 ~ 2009)
- Global Product Manager/ Solar Program Manager

Brooks Automation (1999 ~ 2007)
- High Tech/Semi Industry Director, Software division

Hanyon Tech (1994~ 1999)

MIEX System (1994 ~ 1995)

Consilium (1991~ 1994)

Digital Equipment Corp (1986 ~ 1991)
- Manufacturing Solution Engineer (1986.06 ~ 1991.09)
I. What is Global Operations?

II. How to Make it Real

III. Case Study

IV. Conclusions
Why Global Operations is important

I. What is Global Operations?

Manufacturing Globalization • Standardizing processes for global consistency

Global Operations • Support for local variations • Mobility • Analytics

Customer X Plants Location Over 90% Overseas

Global R&D Collaboration

Smart Factory

Vertical Integration & N/M Manufacturing System

- IoT, Cyber Physics System
- Modularization & Digitalization
- Agility

Legacy

24-hr research and development
Why Global Operations is important

I. What is Global Operations?

Challenges

| Multiple mfg. sites worldwide | 1. Support for local variations and requirement  
|                              | 2. Collaboration with suppliers and outsourcing partners  
|                              | 3. Growth of emerging markets  |

| Diversified Demands | 1. Customers’ diversified tastes  
|                     | 2. Various customer classes  
|                     | 3. Short product lifecycle  |

| Competitive Production Cost | 1. Increased labor costs  
|                            | 2. Increased material costs  
|                            | 3. Intensified price competition  |

| External Business Environment | 1. Exchange rate, Tariff changes  
|                               | 2. Region trade agreement – economic bloc  
|                               | 3. Regulations & trade barriers  |

To improve organic integration of

Supply Chain

Procurement ~ Delivery and

Value Chain

R&D ~ Manufacturing

Single Instance ERP

Single Chain SCM

Single Source PLM

Single Platform MES
What is the Global Operations in manufacturing?

I. What is Global Operations?

Requirements for Global Operations

1. Supports each factory’s strategy and specific characteristics and process
   - Factory Operations Support

2. Operates them at global level through system integration
   - Virtual One Factory

3. Optimizes global operations by providing an integrated view on factory operations
   - Global Single View

Type of local operations

<table>
<thead>
<tr>
<th>Localization</th>
<th>EMS, KD</th>
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</thead>
</table>
| • Own design & manufacturing ability
• Form a production complex | • R&D, Design and marketing
• Excellent supply chain
• Globalization |
• Roll-out after system standardization (implement the same platform for all sites)
• HQ controls production plan and material management
  Production Plant focus on manufacturing
• Each plant runs its own MES, and HQ collects summary data and reports

**Enterprise Production Planning**

HQ develops production plan considering the company's resource capacity as well as materials inventory in overseas plants.

**Plan Adjustment and Confirmation**

• Overseas plants adjust detailed plans and confirm the production plan for each production line according to the conditions of the plants
• Overseas plants operated by requesting required materials when needed.
Phased approach is recommended for the Global Operations.

- **Phase 1**: Global Operations Standardization
- **Phase 2**: Global Operations Platform
- **Phase 3**: Global Operations Control – Globally optimized manufacturing governance system

### Global Operations Standardization
- Processes standardization
- Manufacturing master data standardization
- KPI Standardization

### Global Operations Platform
- UX Standards
- Advanced IT based framework
- Latest IT Tech. devices

### Global Operations Control
- Global Control Center
- Global Optimization
- Standard Infrastructure
Logical standardization for global operation of multi-factories

### Main Items

**Process Standardization**
- Defining common and specific processes
- Supporting specific and common features

**Mfg. Master Data Standardization**
- Creation ~ Release Lifecycle
- Supporting 9 processes such as operations, logistics, etc.

**KPI Standardization**
- Define and compare key performance indicators
- KPI real-time analysis and monitoring

### Customer Benefits

- Quick new factory deployment and roll-out
- Improving product quality through one-stop analysis of the whole spectrum from parts to processes to shipment to market quality
- Leveling up manufacturing competitiveness through rapid spreads of best practices
Flexible manufacturing system is required to rapidly respond to a fast-changing business environment.

<table>
<thead>
<tr>
<th>Main Items</th>
<th>Customer Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UX Standards</strong></td>
<td>• Enabling intuitive decision-making</td>
</tr>
<tr>
<td>• User interface (Look &amp; feel)</td>
<td>• Enhancing flexibility to requirement changes</td>
</tr>
<tr>
<td>• Configurable Smart OI</td>
<td>• Improving systems operations efficiency</td>
</tr>
<tr>
<td><strong>Advanced IT based framework</strong></td>
<td>• Reliability and safety for system changes through RTS</td>
</tr>
<tr>
<td>• Standard H/W &amp; S/W framework</td>
<td>• Establishing smart work environment and saving costs providing devices with services</td>
</tr>
<tr>
<td>• RTS, Interface Hub, Remote mgt.</td>
<td></td>
</tr>
<tr>
<td><strong>Latest IT Tech. devices</strong></td>
<td></td>
</tr>
<tr>
<td>• Mobile, RFID, Bar Code I/F</td>
<td></td>
</tr>
<tr>
<td>• Window based Label Mgt.</td>
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</tbody>
</table>

**User experience**
- Usability & accessibility
- Information architecture

**Mobile standard**
- Window-based Printer server

**Integrated label MGT.**
- Window-based Printer server

**RTS, Smart OI 3-tier web-based architecture**
- Reliability & Compatibility
- Cost Efficiency

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**II. How to Make it Real**

Flexible manufacturing system is required to rapidly respond to a fast-changing business environment.
Phase 3 – Global Operations Control

Operation of global production system through platform-based flexible manufacturing system

Main Items

- **Global Control Center**
  - 1st, 2nd line corresponding ITSS system
  - Real time monitoring & remote control
- **Global Optimization**
  - Enterprise-wide optimization with ERP and SCM interfaces
  - Production simulation
  - Rapid best practices spread
- **Standard Infrastructure**
  - Standard infrastructure
  - Federated architecture

Customer Benefits

- Boosting operational stability and field responsiveness to emergency through 365 * 24 support
- Improving manufacturing competitiveness by shifting from factory-wide optimization to enterprise-wide
- Enhancing flexibility to respond to production changes and reducing inventory thru optimizing global production
- Strengthening HQ’s IT governance function (development strategy, control, and best practice deployment, etc.)
Quantitative Results

### System efficiency ratio

<p>| | | | | | | |</p>
<table>
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<tr>
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</thead>
<tbody>
<tr>
<td>MDM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>93.5%</td>
<td></td>
</tr>
<tr>
<td>I/F decrease ratio</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>89.1%</td>
<td></td>
</tr>
<tr>
<td>Screen standardization ratio</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>73.0%</td>
<td></td>
</tr>
</tbody>
</table>

### The effectiveness of system utilization

- Data throughput (day): Over 650 GB (G-ERP by 4.3 times)
- Number of users (day): Over 100 thousand (G-ERP by 4 times)
- OI Utilization: Usage 100%

### Improvement effect of cost

- Quality Improvement: 67%
- Equipment Operation Improvement: 8%
- Common: 10%
- Optimization of Material Management: 15%

※ Annual cost effect

III. Case Study
Securing solid track record on system implementation Global One Factory system for 31 factories world-wide.

Having the world-best standardization & integration Know-How
- Integration Framework, Standardized Roll-out Procedures, Templates, Knowledge Assets (1.6 million), 300 Experienced Resources, etc.

Providing a Robust Governance (vs. physical Integrated systems)
- Solutions over the whole processes - Strategy, Process Optimization, System implementation, Outsourcing

Utilizing Standards for successful Global Operations
- Reference of International Standards to Involvement for building Standards based on actual experiences
Appendix
Federated architecture

Federated integration of operating environment based on master data standardization and data visibility.

Federal System

• Federated Architecture is characterized by a control center, loosely coupled systems, information sharing and orchestration of activities.
  - suitable for large-sized businesses or a business with multiple business units and supply chains
  - flexible and quickly adapts to the changes in the legacy structure or tools
  - provides required data in the right place at the right time
  - allows access to the integrated data of de-centralized systems

Federated Mfg. Governance

• Overall management and control of and between production lines is necessary
  - Loosely Coupled

Synchronization

• Standardization and synchronization of execution master data and processes

Manufacturing Visibility

• Ensure Plant Floor Visibility

Enterprise integrated management/control

- Library (common/specialized)
- master data

Identify/Request BU-specific project

Utilization of subsidiaries:
Creation and collection of MES operation data

Appendix
Federal System
Federated Mfg. Governance
Synchronization
Manufacturing Visibility

Enterprise integrated management/control
Library (common/specialized)
HQ MES
Global Library
MBI
MMDM

Identify/Request BU-specific project
Analysis
Distribution
Performance gathering
Data Standardization by industry reference model (ISA-95, OAGIS)

<table>
<thead>
<tr>
<th>Applications</th>
<th>Interoperable Data Model</th>
<th>Component Data Model</th>
<th>Global MES Module</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterprise Level</td>
<td>Industry Standard</td>
<td>Specification</td>
<td>Production Management</td>
</tr>
<tr>
<td>ERP</td>
<td>Enterprise</td>
<td>Resource</td>
<td>Quality Management</td>
</tr>
<tr>
<td>SCM</td>
<td>MES</td>
<td>Material</td>
<td>Specification Management</td>
</tr>
<tr>
<td>Shop Floor Level</td>
<td>S95/OAGIS</td>
<td>Schedule</td>
<td>Resource Management</td>
</tr>
<tr>
<td>MES</td>
<td>SEMI PCS/EPT</td>
<td>Quality</td>
<td>Manufacturing BI</td>
</tr>
<tr>
<td>Automation</td>
<td></td>
<td>Traceability</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Performance</td>
<td></td>
</tr>
</tbody>
</table>
Refer Industrial Standards to define the data model for Global Operation as Integration and Interoperability aspects.

**B2M Exchanged Information Categories**

**Enterprise Information**
- Plant Production Scheduling, Operational Management, etc
- Production Capability Information (What is available for use)
- Product Definition Information (How to make a product)
- Production Schedule (What to make and use)
- Production Performance (What was made and used)

**Manufacturing Control Information**
- Area Supervision, Production Planning, Reliability, Assurance, etc

**Data Model**
- Production Schedule: Data model to manage Demand (Production Order)
- Production Performance: Data Model to track the real time Production Status (Lot Status)
- Production Definition: Data Model for Reference data for Demand Allocation (Manufacturing BOM, Test Spec)
- Production Capability: Data Model for Work Order (Pegging information between Production Order and Lot)

**Infra Structure to manage Real Time events**
- Standard XML Message Format
- B2MML Schema
Data Standardization for B2M (Business To Manufacturing)

Production Request

Component Data

- Specification
- Resource
- Material
- Schedule
- Quality
- Traceability

Global MES
Data Standardization for B2M (Business To Manufacturing)

Create Production Order

Component Data
- Specification
- Resource
- Material
- Schedule
- Quality
- Traceability
Process Standardization to support Multiple Manufacturing Styles

Single Manufacturing Process to cover all factories and products to support the actual manufacturing floors and complex line operations (Upward trend standardization)

### Process Innovation

<table>
<thead>
<tr>
<th>Product</th>
<th>Cell Planning</th>
<th>SMD Planning</th>
<th>PBA Planning</th>
<th>Outsourcing line planning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product A</td>
<td>A MES</td>
<td>A MES</td>
<td>A MES</td>
<td>APS</td>
</tr>
<tr>
<td>Product B</td>
<td>A MES</td>
<td>A MES</td>
<td>A MES</td>
<td>B MES</td>
</tr>
<tr>
<td>Product C</td>
<td>Manual</td>
<td>A MES</td>
<td>Manual</td>
<td>B MES</td>
</tr>
<tr>
<td>Product D</td>
<td>N/A</td>
<td>A MES</td>
<td>N/A</td>
<td>B MES</td>
</tr>
</tbody>
</table>

### Process Modeling

- **Dedicated line to one product**
- **Shared line for Multiple products**

- **Single Process Structure**
  - Logical Integrated and Library concepts to absorb all difference and variance
  - Support mixed and multiple product manufacturing by a physical line.
KPI Standardization to improve manufacturing execution capabilities

KPI Standard across all factories regardless Manufacturing Products, Different Manufacturing Situations, Multiple locations, and then building a single governance.

- Preparing Abnormal Situation
- Managing Bottleneck Process
- Getting a flexibility of investment for automation

*JIT* (Just In Time), *OEE* (Overall Equipment Efficiency)

Single Measurement for Manufacturing Performance

- Cycle Time
- On-Time
- Labor Productivity
- Man
- Method
- Defect Ratio
- Yield
- Energy Consumption
- Environment
- Machine
- Material

- Managing cause of unscheduled down
- Managing JIT* manufacturing
- * Influencing market quality
- * Managing proper defect production
- * Managing defect ratio of core bottleneck process
- * Considering output
- * Managing output per unit of Input
- * Managing energy consumption per unit of output or goods.

- production units per person
- Managing proper the number of labor on the result of output or automation rate
- Influencing market quality
- Managing proper defect production
- Managing defect ratio of core bottleneck process
- Considering output
- Managing output per unit of Input
- Managing energy consumption per unit of output or goods.
Adopting the cutt[ing-edge IT solution] to ensure system stability and efficiency

Standardization of fundamental technologies ensures system stability and efficient implementation and operation, and the advanced technologies are used to provide flexible and scalable architecture.

**Test automation maximizes stability**

- Problems occurred during a release have significant impacts on the entire production system.
- Deployment of flawless applications increases stability and minimizes the impact of changes.

**Increased coverage**

- Improved system reliability critical defects are detected in advance and human errors are prevented

**Integrated test platform**

- Adopting test automation system
  Ensuring productivity, flexibility and efficiency of test execution
- Executing regression test based on core workflow Analyzing interface between modules (End-to-End)

**Test asset pool**

- Building and reusing test pool
  Accumulating scenario data

- Test coverage increased after continuous test execution based on accumulated regression test scenarios
Establish best performance supporting system with best resource that support global manufacturing system effectively.

**Mobile Solution in Shop-Floor**

- **Module**
  - PM
  - QM
  - RM
  - BI

- **additional function**
  - Communication
  - Video
  - Voice
  - Message

Collect process information with Smart phone’s various input function.

**Smart Work Environment**

- **Label Solution**
  - Provide Design Tool for label, Spec., Numbering rule integration.

  - Model Spec. Management → Mapping Model & Form → Label Issue → Label Numbering

  - Provide Window Based Solution, which is base on graphic.

- **Factory Monitoring Board**
  - Support intuitive decision making with visualization of information

- **Label Solution**
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  - Support intuitive decision making with visualization of information

**Screen**

**Camera**

**Barcode Reader**

**RFID Reader**

Global Control Center

Support non-stop Production with 24/7 global monitoring system and Local factory’s Performance and operating level is improved as H/Q level.

Global Operations Center

1. **Service Operation**
   - Monitoring VOC, change requests, releases control (service desk included)
   - Emergency handling

2. **Global Monitoring**
   - Early detecting abnormality by real time monitoring UI/OI, I/F, Batch and DB events

3. **Global Integrated Command**
   - Real time monitoring and control of entire plants worldwide
   - Central governance

MES Operation Center(HQ) runs 24hrs * 365days

- IT-VOC
  - VOC Registration
  - VOC mgt.

- MES Operation
  - Solving Issue
  - Responding VOC
  - Root-cause analysis

Global Monitoring

- Action Taken remotely
- Video conference
- Remote control
- Imagery Intelligence

Global Integrated Command

- Manager
  - Real time monitoring & control

Local Factory

- Status Information

Infrastructure Operation

- Work order
- Issue report
- Remedy

Support non-stop Production with 24/7 global monitoring system and Local factory’s Performance and operating level is improved as H/Q level.
Adopting the **Advanced IT solution** to ensure system stability and efficiency.

Standardization of fundamental technologies ensures system stability and efficient implementation and operation, and the advanced technologies are used to provide flexible and scalable architecture.

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**Standard Framework**

1. **Level 4** Planning & Logistics
   - Provide standard interface among Level 4 system
   - Monitoring of manufacturing status (2, 3 sever can be combined according to condition)

2. **Level 3** Dynamic Configuration & Execution
   - MES Component Set up with Dynamic Configuration

3. **Level 2** Data Acquisition & Control
   - Provide standard interface for Level 2 system

4. **Global Standard Framework**
   - Manufacturing Standard Interface
   - HTTP

5. **Global MES Platform**
   - gMDW
   - Global Integrate Monitoring
   - Deploy Repository
   - Global View
   - Mobile View
   - Global Control & Operation

Local management in Local MES
Global management and View in HQ