Smart Manufacturing in the Semiconductor Industry - *Realizing the Digital Factory Vision*

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Semiconductor Industry Trends and Impacts

Shifting Growth Segments

<table>
<thead>
<tr>
<th>2016</th>
<th>2025</th>
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<tbody>
<tr>
<td>$16B</td>
<td>$62B</td>
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<tr>
<td><strong>IoT</strong></td>
<td><strong>Semiconductor Value</strong></td>
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<tr>
<td>$32B</td>
<td>$51B</td>
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<tr>
<td><strong>Automotive</strong></td>
<td></td>
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<tr>
<td>$0B</td>
<td>$20B</td>
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<tr>
<td><strong>5G</strong></td>
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<tr>
<td>$4B</td>
<td>$131B</td>
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<tr>
<td><strong>AR/VR</strong></td>
<td></td>
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<tr>
<td>$5B</td>
<td>$50B</td>
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<tr>
<td><strong>AI</strong></td>
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Current Trends

- Growing # of Smart Connected Devices.
- Automotive Industry driving end-to-end traceability and higher quality requirements.
- Increasing Requirements to achieve zero level defects.

Impacts of the Trends

- Shorter technology innovation adoption.
- Inability to achieve zero defect will cause loss of revenue/market share.
- More difficult to enable collaboration across and through the Supply Chain.
- Manufacturing environment needs to be closed loop, intelligent and integrated.

Global Foundries presented the data at the ISS Summit Jan 2017 based on Gartner’s Actuals and their forecast data.
Industry Focused Application Platforms

Mobile
Automotive
IoT
HPC
Challenge of Semiconductor IC Lifecycle

Current state of semiconductor value chain

- Integrated-circuit design, process development, and factory setup
- New-product introduction and ramp-up
- Wafer manufacture
- Assembly and functional testing
- System integration and after-sales
- End of life

- 50% increase in time in test and verification over the last few years
- About 12–18 months of iterative debugging
- 80–90% utilization and 85–95% integrated yield
- About 30% of capital expenditures relate to testing that does not add value
- No end-to-end traceability at device level
- Lack of feedback loop at end of life
Current Environment for the Challenge

**Will these systems co-work together with quick response?**

Will an architecture built up over 20 years support the big pull due to the Digitalization of your customers?

Is this sufficiently robust, flexible and transparent to support your own Digital Enterprise?
Proposed Solution for The Challenge

*Industry 4.0 digital enterprise lifecycle solution*

### Ideation

Strengthening Product Development through Systems Engineering and Simulation

### Realization

Integrating “Product” and “Production” for closed-loop manufacturing

### Utilization

Expanding analytics across the entire lifecycle leveraging the IoT
Starting from Product Design to Manufacturing Operation Data Analytics

Semiconductor digital enterprise lifecycle solution

- Ideation
  - Product Design
  - Electromechanical Systems Design to Manufacturing
  - IC Design to Silicon
  - Software ALM
  - Model-based Analytics

- Realization
  - Digital Manufacturing
  - Manufacturing Operations Management
  - Lifecycle Analytics
  - Test and Validation
  - Collaboration and Lifecycle Management

- Utilization
  - Portfolio Alignment
  - Data-driven Analytics

Leading-edge systems companies are becoming the new system-on-chip designers
Starting from Product Design to Manufacturing Operation Data Analytics: Examples

- **Electronics Design Automation**: Silicon design from system design to RTL and physical verification till mask making and lithography computation.
- **Global MES**: Device level traceability across plants allowing for better Root Cause Analysis.
- **Requirements Management**: Workflows integrated into the data model that give visibility for phase gate planning and interdependencies regarding to product specification traceability.
- **Integrated Design to Silicon Information**: End-2-end product record visibility from design data to mask layout and shop floor information.
- **Product Lifecycle Analytics**: Analytics on Tool, MES, Engineering, & Test data sets leading to process and design improvement.
Digital Manufacturing

Factory Integration

Smart Manufacturing
Digital Manufacturing
Leverage integrated Factory Automation, MOM, PLM to build solution

Manufacturing Operations Management

Production Execution

Run-Time Manufacturing Operations Service Bus

Manufacturing Execution System
Quality Execution System
Advanced Planning & Scheduling
Enterprise Manufacturing Intelligence

PLM

Product Lifecycle Management

Design Engineering
Simulation & Test
Manufacturing Engineering
Lifecycle Analytics
SLM

EDA

Automation

SCADA
Factory Integration

Leverage Common Plant Model to build the solution

PLM

Common Plant Model

BOP Execution

Production Screens

Manufacturing Intelligence

Run-Time Manufacturing

Operations Service Bus

Run-time process image

Real-time Data

IOT Device

Auto-registration

IOT Device

Auto-registration
Smart Manufacturing
Leverage Digital Twin as The Vehicle to Realize Smart Manufacturing

- The virtual and the real worlds are linked by the **Manufacturing Master Data Model** and the **Common Plant Model** created from Automation.

- Decisions can be made based on **real-time data from Automation**.

- Feeding back all relevant information from production execution creates a nearly real-time image of the **digital twin** of product, process, and resources.

- Analyze the **engineering and manufacturing big data** with **machine learning model**.
Successful Industry 4.0 Electronic Factory Solution

Example for proposed solution

Amberg plant

- **Fast!**
  - ~1 Million monthly production of PLC products

- **Flexible!**
  - 60,000+ customers worldwide each year
  - 24 hour lead time for new orders

- **Efficient!**
  - ~12 dpm means near perfect quality – every time

Siemens’ state-of-the-art Electronic Works facility in Amberg, Germany, integrates its manufacturing, production and automation systems to process 1.6 billion components from 250 suppliers with 99% reliability.
Takeaway

• Industry challenge comes faster and complex than before – are you ready to cross the chasm?

• Industry 4.0 solution provides the reference to stand up to the challenge

• Siemens has invested $6B for the past two years in semiconductor solutions and we have best practice at Industry 4.0

• Visionary companies have already started their digital journey

• What’s your first step towards Digital Enterprise?
Thanks for Your Attention

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