Automation Systems & IT within Intel’s High Volume Manufacturing

2006 MIT Manufacturing Summit

Bimal Dey / Anthony Maggi
AGENDA

- Intel’s Manufacturing Environment
- Automation Drivers/Domains
- Focus Topic: Automated Mat’l Handling
- Focus Topic: Process Control Systems
Environment: Highly Global

Challenge: Deploy CE! IT capabilities across the globe
Manufacturing Environment Vectors

Technologies

Automation reliability

Computing security

18 month cycles

Global dispersion

Affordability

Competitive challenges

Supply chain optimization

Cost of excursions

Quality expectations

Each are drivers as well as opportunities for IT
IT Infrastructure Challenges in Mfg

Environmental vectors are confounded by key challenges including…

- Complexity
- Exploitation of security vulnerabilities
- Explosive usage growth of products and services

Equates to continued cost pressures
AGENDA

- Intel’s Manufacturing Environment
- Automation Drivers/Domains
- Focus Topic: Automated Mat’l Handling
- Focus Topic: Process Control Systems
Key Automation Drivers for Mfg

- Rapid Factory Cycle Time
- Higher People Productivity
- Lot size reduction
- High Equipment Availability & Utilization
- Zero set up time
- Rapid New Product Switch over
- WIP Matched to Current Needs
- Optimized Space Management
- Error free processing
AGENDA

- Intel’s Manufacturing Environment
- Automation Drivers/Domains
- Focus Topic: Automated Mat’l Handling
- Focus Topic: Process Control Systems
**Key Points:**

1. Production Equipment standards and capabilities were Critical to achieving 100% Intrabay Automation

2. AMHS Standards enable mix and match of supplier tools to get Best In Class equipment

3. Major time focus was spent integrating software capabilities with Production and AMHS Equipment

4. All in-line process and metrology equipment must be [and has been] connected to the AMHS
300mm Automation – Fully Integrated

Goal: Direct Tool to Tool WIP
Movement without human intervention

F11x → 2.6miles of track
Remote Operations Center in F11x
AMHS Summary

- Intel has achieved 100% Integrated Intrabay AMHS in its 300mm Fabs
- 100% integrated intrabay could not have been achieved in the same timeframe without open industry standards
- Rapid throughput AMHS transport systems are needed to meet demanding lot cycle times, fast run rate production equipment, and complex process technology scenarios
- Future capabilities are planned to extend the current technology to fully (near 100%) automated decision making for intrabay scheduling and dispatching
Process Control Systems

- Automated Process Control (On Line)
- Fault Detection Systems (On Line)
- Statistical Process Control Systems (Off Line)
Overview of Process Control Systems

Typical Usage of Process Control at a Process Tool

**SPC** – Monitor statistical data and stop the tool if trending to OOC 100% of the Fab

**FDC** – Monitor equipment event and time series data. Stop tool when ranges or profiles are exceeded *Pervasive Implementation*

**Run to Run APC** - Use feedback and feed forward metrology and sensor data to adjust processing at the lot and wafer level. Drive for multi-step control. *Various % - Decision is based on problem being solved*

**Sensors** – Use 3rd party and embedded sensors to provide FDC & R2R APC data *Various % - Decision is based on problem being solved*

Essential Data standards include SEMI E40, E94, E90 for wafer level control & tracking
Evolution of Intel Process Control

200mm Wafers
1st Generation (1993)

200mm Wafers
3rd Generation (1999)

300mm Wafers
2nd Generation (2006)

300mm Wafers
4th Generation (2007)

Time axis

200mm Gen 1
- Point solutions for SPC spread across the factory
- Ad hoc and limited FDC and Run to Run APC Control Systems
- Rudimentary Control Analytics

200mm Gen 3
- Factory wide systems & usage of SPC & FDC
- Point Solutions for Run to Run APC
- Basic FDC & APC Control & Yield Analysis

300mm Gen 2
- Factory wide systems & usage of SPC & FDC
- Maturing FDC & APC Control Analytics
- Reusable Run to Run APC Framework with litho coverage
- Advanced Yield Analysis and Analytics

300mm Gen 4
- Factory wide systems and usage of PCS (SPC + FDC + APC)
- Advanced FDC & APC Control Analytics
- Advanced Yield Analysis and Analytics moving toward predictive models
SUMMARY

- High Volume manufacturing in Semi industry presents many unique challenges
- Advances in AMHS and PCS has been key to addressing some of these challenges
- Continued advances needed in these two areas to keep pace with the “Moore’s law” and rapid pace of the Semi technology
Questions
References

- Nimish Shah, “ASMC Keynote Presentation 2005“
- J. Wu and R. Madson, “APF in Intel’s 300mm Execution Control Strategy” in Brooks Worldwide Automation and Performance Symposium, 2002
- B. Sohn, D. Pillai, N. Acker, “300mm Factory Design for Operational Effectiveness”, IEEE/ASMC Conference, SEMICON Europa, Munich, Germany, April 2000