Supplier’s Prototyping Experience

e-Manufacturing Workshop

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Purpose of This Prototyping

• Nobody knows what kind of EE data we need!
  – Data that is valuable for manufacturers and users for diagnosis of equipment base an effective manner
  – Data that enables the third party consignment of equipment engineering operations
  – Data that enables the equipment performance improvement by the equipment supplier and prompt ramp up of equipment operation
  – Data of what volume and how detailed?

• Need to investigate the above mentioned data in prototyping
  – Answer important questions above by showing actual data and possible applications
What Kind of EE Data Do We Need?

• Focus of this prototyping report
  – Data for Equipment Base Functionality
    • Detailed event data for equipment operation
    • Major component operation data
      – Such as mass-flow controllers and temperature controllers
        » Commonly embedded in equipment
    • Need to confirm Detailed Equipment Event data
      – Data for process performance monitoring/FDC
  
• Followings are out of scope
  – Process performance monitoring
  – EE data transmission capability through EDA Port
  – Equipment performance evaluation
Data Obtained in Prototyping

• Data collection was limited as below
  – Detailed Equipment Event Data (100m sec resolution)
    • Device level and Step level
  – Analog data (Continuous 1sec sampling)
    • Vacuum gauge data
    • Gas flow rate data

Process related data was collected for supplemental purpose

e-Diagnosis Preventive Maintenance System
Typical Device Control and Event
### DEE Data Base

#### Sample of Restored DEE

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What We See in The Prototype

- Examine “visibility” of device (actuator) operation by DEE Data
  - Wafer lifter operation in terms of time
  - Load-lock door operation in terms of time
- Examine “visibility” of sequence steps in terms of operation time by DEE Data
  - Wafer loading time to process chambers
  - Wafer handling and process times, process execution intervals
    - Single layer film deposition by one process chamber
    - Bi layer film deposition process by two process chambers
- Examine “visibility” of equipment operation consequence
  - Analog data were examined together with operation consequence and evaluate benefit of correlating DEE data with them
    - Pump down from atmospheric pressure
    - Vent up to atmospheric pressure
    - Process pressure
Actuator Operation Analysis

Time domain observation: Device Level

- **Observation**
  - Wafer lifter down operation time dispersed for a certain period of time and then stabilized

- **Point to stress**
  - Very high sensitivity due to simple but repeated recording
    - Only few % of time the excursion occurred
    - This is usually identified as “Poor Reproducibility”
  - May detect such malfunction over good # of hardware “devices”
Actuator Operation Analysis

Machine to machine difference

- **Observation**
  - There are open/close operation time difference between two load-lock doors
  - They are stable for each

- **Point to stress**
  - Physical machine-to-machine matching should be encouraged through DEE data analysis
  - Such data become Base Line Data
Machine to machine difference

Actuator Operation Analysis

- **Observation**
  - Lifter UP operation in LA load-lock chamber has instability
  - This instability was found to be linked with unloading operation
- **Point to stress**
  - Operation consequence is indispensable to find root cause
  - DEE provides important consequence data

**LA_WAF_LIFTER TIME is longer when LL UNLOAD.**
• **Observation**
  – Vent gas flow rate was changed

• **Point to stress**
  – Human operated artificial change may be found by DEE
  – Confirmation of proper maintenance work can be systemized
• Observation
  – Wafer loading time to a process chamber varies (3 levels) in TAT mode (“fast as possible”): actual wafer flow changes depending on process time settings
  – Found this is related to the internal H/W state of process chamber

• Point to stress
  – Consequence data provided by DEE is indispensable to investigate
  – DEE can provide truly meaningful wafer tracking
Bi-Layer Process Consequence Analysis

Process Step Level Analysis

Bi-layer Deposition

- Observation
  - Bi-layer deposition interval varies for every 6 wafers in TAT mode

- Point to stress
  - This pattern dramatically changes with time settings

Consequence information is again indispensable

Interval in TACT mode
DEE Data for Consequence Analysis Application

- **Observation**
  - There are differences among pump-down curves
  - Data should be reviewed with the consequence before pump-down
  - Singular analog data could not provide more than itself
  - This allows confirmation of proper wet cleaning operation

- **Point to stress**
  - Simple process related analog data becomes valuable if correlated with DEE data

### Confirm atmospheric exposure time from DEE data

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Summary(1)

- ES can use EES at every step of Equipment Life Cycle
  - Production: H/W & S/W debugging
  - Inspection: Base Line Data adjustment, Quality Assurance
  - Installation: Shorter ramp up time
  - Operation: OEE Up (Overall Equipment Effectiveness)
    - Watch machine status based on Base Line Data
    - Lead to Preventive Maintenance
    - Shorten MTTR, and expand MTBF
  - Modification: Kaizen & Confirmation, CIP
  - Next Generation: Feed back more science to designing
Summary(2)

• DEE data does the job for base functionality monitor

• For sufficient equipment operation support
  – Data share is a must
    • Between user and equipment vendor, or third party
  – e-Diagnostics becomes possible for PVD systems

• Optimized task sharing leads to e-Manufacturing
  – More resource focus onto process performance at Equipment Supplier
  – More improved application programs for better EE operation available from third parties
  – More systemization of EE operation
  – Device makers enjoy higher OEE!
Summary (3)

• Our next step
  – eU- Support: ULVAC NEW BUSINESS MODEL
    • Thorough optimization of EE operation support
      – parts supply
      – maintenance support & resource scheduling
      – remote monitoring
      – total OEE support