

**Factory Integration
Public Presentation
2009 ITRS Winter Meeting
@HsinChu**

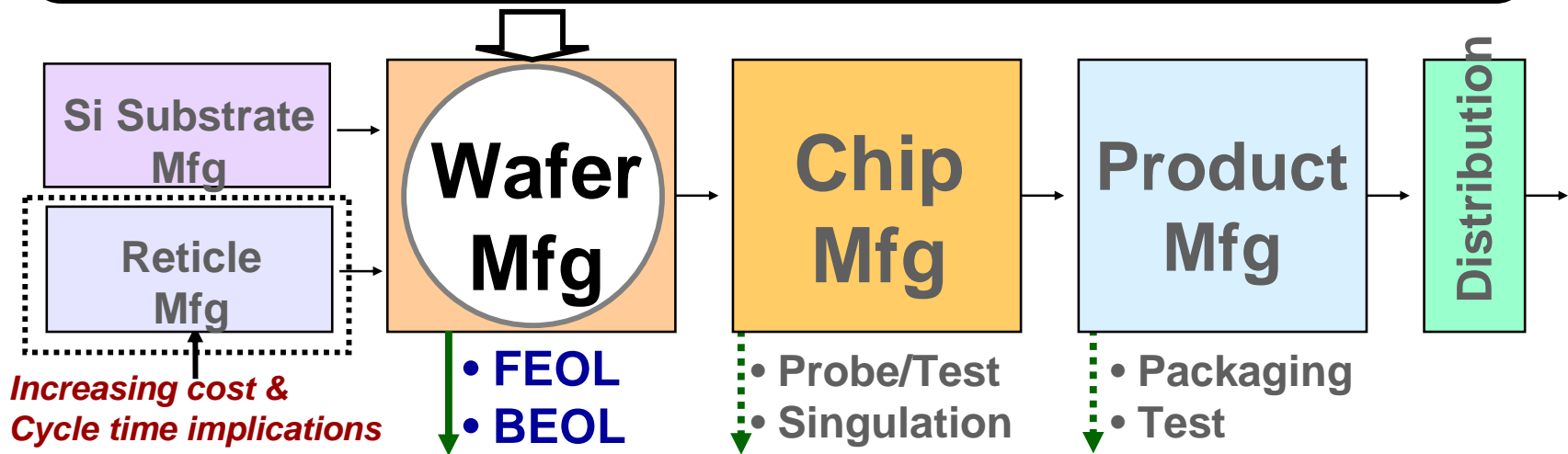
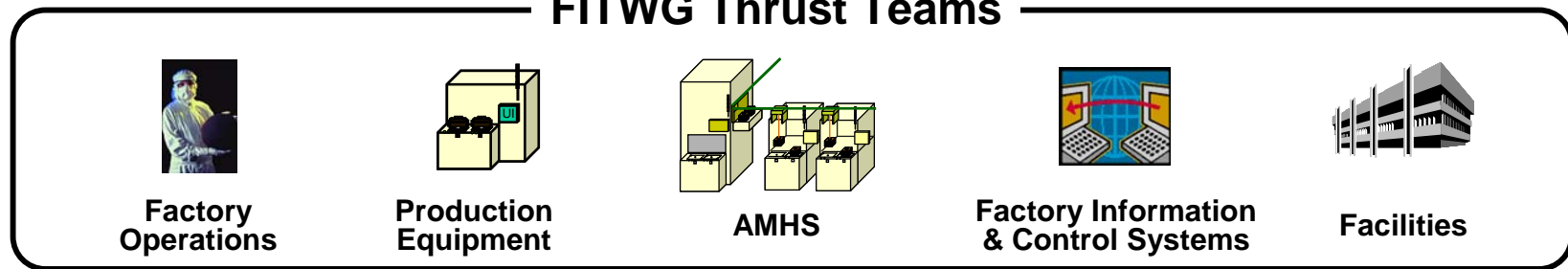
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International Technology Roadmap for Semiconductors

FI Focus on Wafer Manufacturing

FITWG Thrust Teams



Factory is driven by Cost, Quality, Productivity, Speed, and Flexibility

- ☞ Reduce factory capital and operating costs per function
- ☞ Faster delivery of new and volume products to the end customer
- ☞ Efficient/Effective volume/mix production, high reliability, & high equipment reuse
- ☞ Enable rapid process technology shrinks as well as systematic productivity waste reduction



Factory Integrations ITWG Activity

Coverage

- Wafer fabrication

Scope

- Sustain the decades-long trend of 30% per year reduction in cost per function
- Integrate all the factory components
 - in order to efficiently produce the required products in the right volumes on schedule while meeting cost targets

■ Team structure

Overall 38 participants

➤ Core team

- ✧ Overall planning
- ✧ Focus areas
- ✧ Cross cut issues

➤ PE: Production Equipment

➤ MHS: Material Handling

➤ FICS: Factory Information and Control Systems

➤ Facility

■ Contribution from industry consortia

- ISMI, JEITA NGF WG, SEAJ, and STRJ



Factory Integration Key Challenges (Near Term)

1. *Implement complex business models and rapidly changing product needs such as high mix and small lot manufacturing for SoC products*
2. *Productivity improvement in equipment utilization and variability reduction in product quality*
3. *Restructuring manufacturing chain and task-sharing scheme for maximize the manufacturing efficiency in 300 mm factory operation*
4. *Productivity waste management for comprehensive optimization in manufacturing efficiency*
5. *450mm technology insertion*



FI Technical Challenge Summary

Requirements	Factory Operation		Factory Resource	Others
	Manufacturing Method	Cycle Time	Overall Eq Efficiency	
FO	Systematic productivity waste management / NGF	Minimize Wait Time Waste	Minimize Equipment Output Waste	
PE	OEE improvements in high-mix production		Bi-directional eq. visualization	Scale up to 450mm
AMHS	Just in time delivery with minimum WIP	Lot-level and wafer-level JIT	High reliability	
FICS	Wafer level process control High system reliability	WIP minimization control		Facilitate more model-based engineering operations
Facility	450mm Contamination control			Energy savings Low emission
Focus Areas	Productivity Waste Reduction as NGF (Next Generation Factory) 450mm			

2009 FO (Factory Operation) Emphasis

■ Next Generation Factory

- NGF requirements defined
 - ✧ As 300mm lot base FO
- Insert prior to 450mm
 - ✧ Avoid 450mm P as industry

■ Systematic productivity improvement

- embedded in FI Roadmap as NGF enabler
- Proactive visualization
- New waste metrics

■ Reinforcement

- Representing high-mix FO requirement in terms of waste
- Visibility of equipment functional activity

■ Metrics deletion

- Mission completed
 - ✧ Those for 300mm insertion
 - ✧ Business matter related

■ Metrics Re-Assignment

- Factory Operation originated metrics stay in FO
 - ✧ Delivery Time etc
 - ✧ NPW moves

■ 13 metrics replaced with 5 new ones

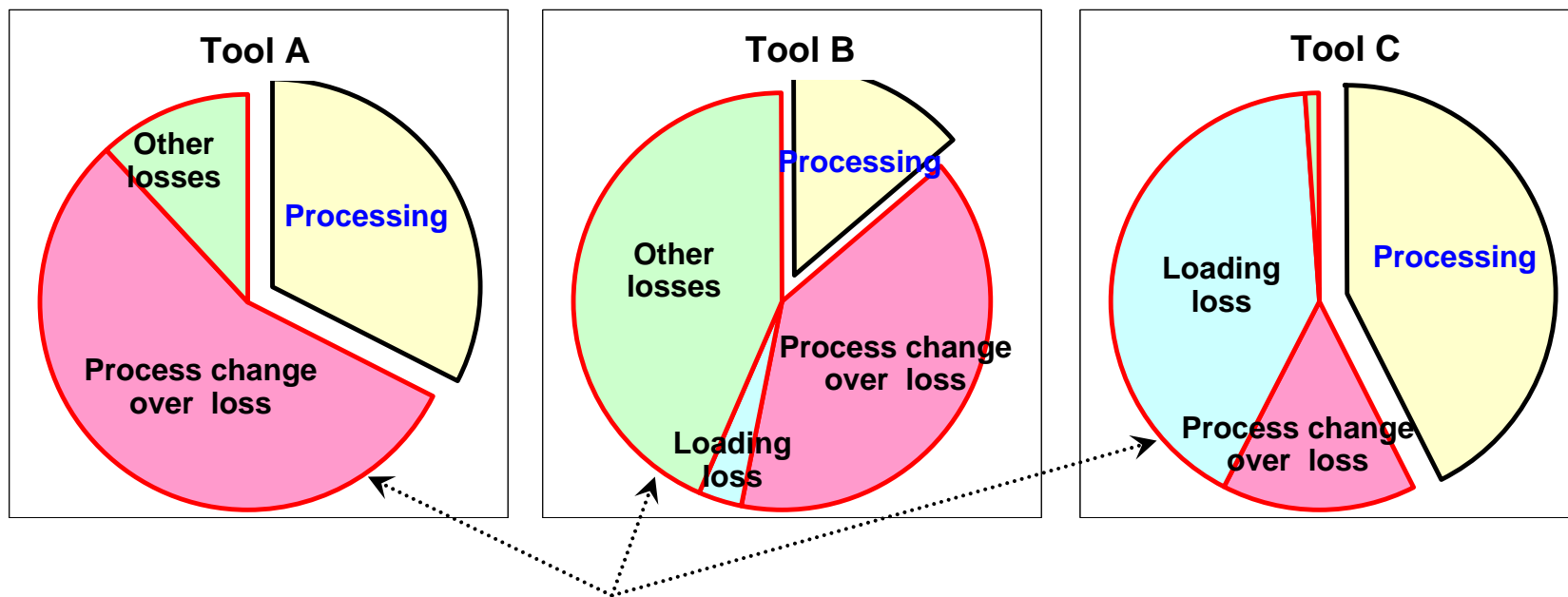


Waste Reduction as Focus Area

- As new driving axis for the entire ITRS roadmap
 - Si Scaling has been the driving axis but may not be enough to stay with the Moore's Law
 - Waste reduction axis is to be paralleled with Si Scaling
 - ✧ Each ITWG is encouraged to analyze waste and bring up comprehensive waste reduction requirement
- FI reason
 - “Waste” is suited for comprehensive improvement
 - ✧ “Redistribution of waste”: Waste can be just moved from one place to another
- Waste metrics development
 - Wait Time Waste, Eq Output (Opportunity) Waste, and Energy Waste



Waste Examples and Metrics



- Significant opportunity for waste reduction
- NGF needs to look into productivity waste collectively

Source: FY2008 STRJ Symposium
OEE: Overall Equipment Efficiency₉



New Waste Metrics: WTW and EOW

Factory WTW (Wait Time Waste)

- Difference between product cycle time and *super hot lot* cycle time in %
 - All tools wait for *super hot wafers*
 - ✧ Super hot lot cycle time represents physical limit value
 - Averaged over fab and normalized by # of mask layers

Factory EOW (Equipment Output Waste)

- Ratio of actual product throughput against ideal throughput
- Represents eq. output losses due to *unavailability, and Dandori operations such as set up*
- Eq internal losses not represent
 - ITRS presents measurement method
 - Same as energy conservation



Long Term TR Table

Single Wafer Manufacturing from 2019

- Paradigm shift in manufacturing method
 - From *Lot-Based FO* to *Wafer-Based FO*
 - From “Job Shop” to “Flow Shop”
- The least wasteful manufacturing method
 - allocated after enough mature waste reduction implementation
- Significant advancement in PE, MHS, FICS required
- PE:
 - All single wafer processors
 - With the same process execution time for a wafer, small FWD (First Wafer Delay) time
- MSH and FICS
 - Exact Just In Time wafer delivery



2009 Factory Integration Summary

- Mission changeover
 - 200→300mm driver →NGF
 - More FO service oriented requirements
 - Less physical requirements except for 450mm
- FI proposes Waste Reduction drive in ITRS
 - In parallel with Si Scaling
 - Encouragement through cross TWG activity
 - Plan Waste Reduction as roadmap at each TWG
- Systematic productivity improvement
 - Systematic waste reduction by systematic PDCA cycle execution as NGF enabler
 - Proactive visualization
 - FI set up 2 waste metrics
- 2010 and after
 - More on waste reduction
 - ✧ Seek for acceptance by other ITWGs and needed FO services
 - Green Initiative implementation
 - ✧ Need energy saving waste management metrics
 - Systematic restructuring of Potential Solution



Acknowledgement

■ 38 active participants

- › Andreas Neuber
- › Brad Van Eck
- › Daihee Lee
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- › Takeshi Ikeda
- › Terry Francis
- › Tom Jefferson
- › Toshiya Hirai

■ Contribution from industry consortia

- **ISMI** in NGF overall analysis
- **JEITA NGF WG** in systematic service requirements
- **SEAJ** in specific technology requirement analysis
- **STRJ**

