

ITRS Factory Integration Presentation

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Hsinchu, Taiwan

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Agenda

- 1. Scope and Difficult Challenges**
- 2. Technology Requirements & Potential Solutions**
- 3. Top Factory Integration Focus Areas**
- 4. Factory Integration Cross-Cut Issues**
- 5. Summary**



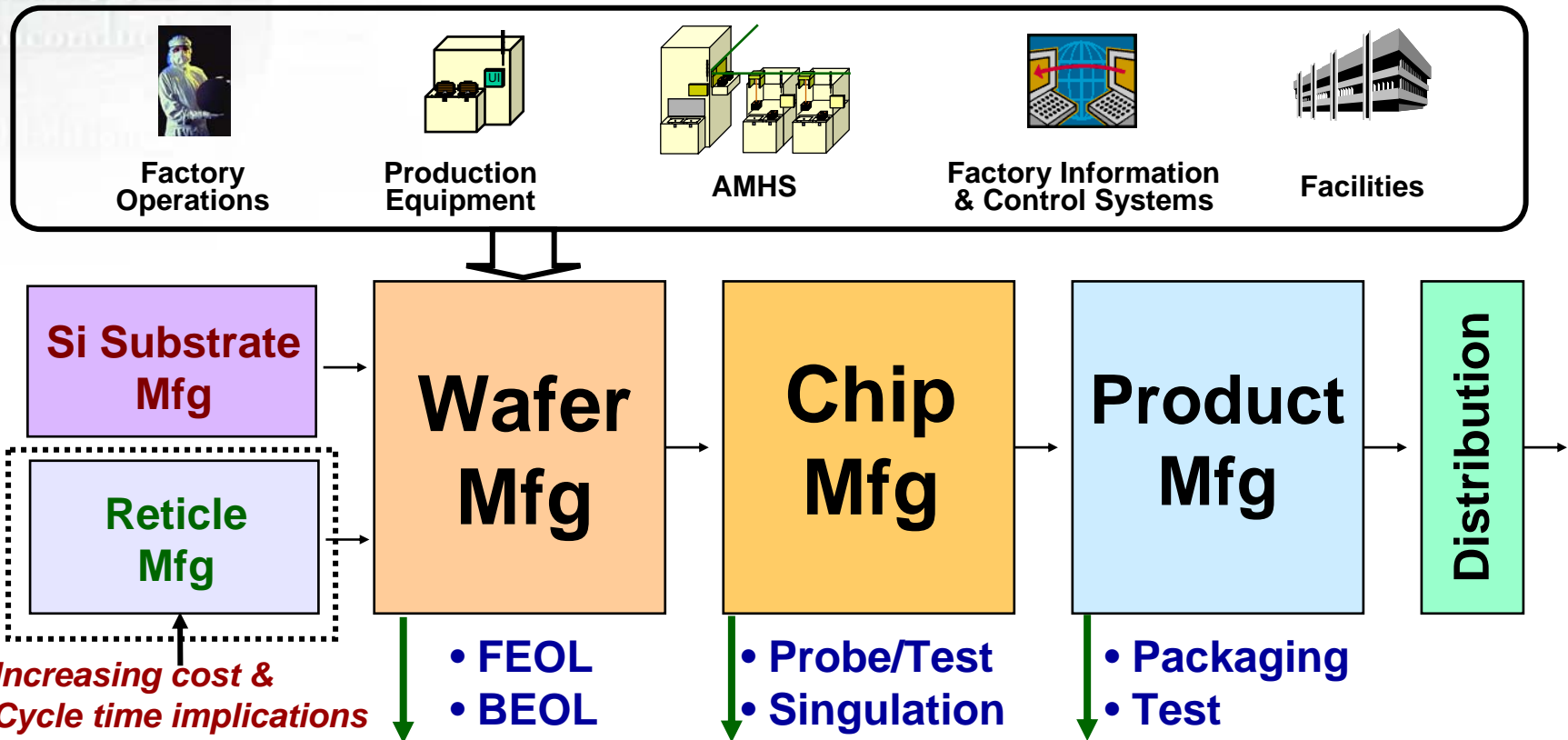
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20+ attended December Taiwan FI TWG meeting.



Factory Integration Scope and Drivers



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

- ☞ 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 and wafer size changes



Key Technologies that will Impact Factory Design

- ★ 2006 and future years were targeted to meet productivity and capture technology requirements
- ★ Key process and device technology intercepts that will impact the factory design are Extreme Ultraviolet Litho (EUVL), New Device Structures, new materials and the wafer size conversion and huge productivity improvements

Near Term Years					
Year	2006	2007	2008	2009	2010
Technology trend (nm)	70	65	55	50	45
Wafer Size (mm)	300	300	300	300	300

Start Planning for 450mm
Started discussions

Long Term Years										
Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Technology trend (nm)	40	35	32	28	25	22	20	18	16	14
Wafer Size (mm)	300	450	450	450	450	450	450	450	450	450

New Device Structures?

EUVL in Production?

Next Wafer Size in Production?



Difficult Challenges Summary

E=Economic/Business
P=Process Technology
M=Manufacturing

Near Term: Current to 2010 $\geq 45\text{nm}$

1. Responding to rapidly changing and complex business requirements [E]
2. Meeting growth targets while margins are declining [E]
3. Managing ever increasing factory complexity [M]
4. Meeting factory and equipment reliability, capability or productivity requirements per the roadmap [M]
5. Meeting the Flexibility, Extendibility, and Scalability needs of a cost effective, leading edge factory [M]
6. Meeting process requirements at 65nm and 45nm nodes running production volumes [P]
7. Increasing global restrictions on environmental issues [E]

Long Term: 2011 to 2020 $< 45\text{nm}$

1. Post conventional CMOS manufacturing uncertainty [P]
2. 300'/450mm factory paradigm changes [M] [E]

Economic and business challenges are equal to our manufacturing and process technology challenges in scope and breadth to attain efficiency and effectiveness







FI Sub team –2006 Update



	Subteam	2006 Update & 2007 Plans
1	<u>Factory Operations (FO)</u> Focus: 1) Reduce Lot Cycle times, 2) Improve Equipment Utilization, 3) Reduce Losses from High Mix	Completed technology requirements table and no new changes to report. Team will start working on small lot size and B/A impact to operations.
2	<u>Production Equipment (PE)</u> Focus: 1) NPW reduction, 2) Reliability Improvement, 3) Run rate (throughput) improvement 4) Equipment Intrinsic efficiency	Completed technology requirements table and made a few small changes to the table. Team will work on equipment loss metrics and 2 nd port data contents.
3	<u>Automated Material Handling Systems (AMHS)</u> Focus: 1) Increase throughput for Traditional and Unified Transport, 2) Reduce Average Delivery times, 3) Improve Reliability	Completed technology requirements table and no new changes to report. Working with FICS on MPH metrics. Working with ISMI on a survey to understand AMHS peak MPH under varying factory conditions.
4	<u>Factory Information & Control Systems (FICS)</u> Focus: 1) Increase Reliability, 2) Increase Factory Throughput, 3) Reduce or Maintain Mask Shop Cycle Time,	Completed technology requirements table and team held meetings to start working on focus areas. Team is working with IMA to review Process Control metrics. Need to find a home for Mask related metrics.
5	<u>Facilities</u> Focus: 1) Reduce Costs 2) Utility 3) Footprint	Completed technology requirements table with few changes (added temperature & humidity specs). Resolved adapter plate metrics location with PE. Team currently working on Green Fab definition and DFF such as equipment sleep mode, evaluate standardization of power supply)



2006 FI Focus Area Summary & 2007 Plans

	Focus Areas	Description
1	Energy conservation/ Equipment Sleep Mode 	Reduce facility operation cost by enabling facility demand based utilization model – including energy conservation
2	“Proactive Visual” manufacturing 	Conquer the high mix, small lot, productivity losses and provide metrics for fab operations.
3	300Prime/450mm Transition 	<u>Target:</u> Historical 30% improvement in cost/cm ² and 50% cycle time reduction in days per mask layer. FI is working with ISMI to define technology requirements for 300Prime/450mm and in 2007
4	FI Cross-cut issues 	Addressed key FI key issues with FEP (SWP vs. Batch), Litho (EUVL), ESH (DFF, Energy), YE (Temp & Humidity) and Metrology (Wafer map standards). Continue to work on 450mm needs.

Factory Integration will update Technology Requirements tables & Potential Solutions tables in addition to working on these focus areas in 2007



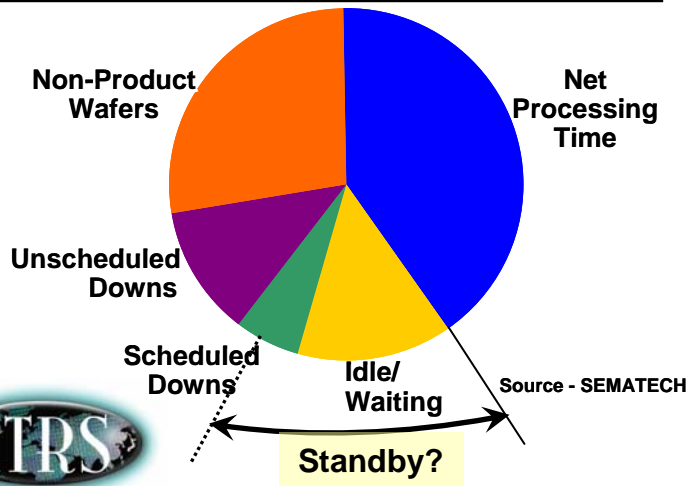
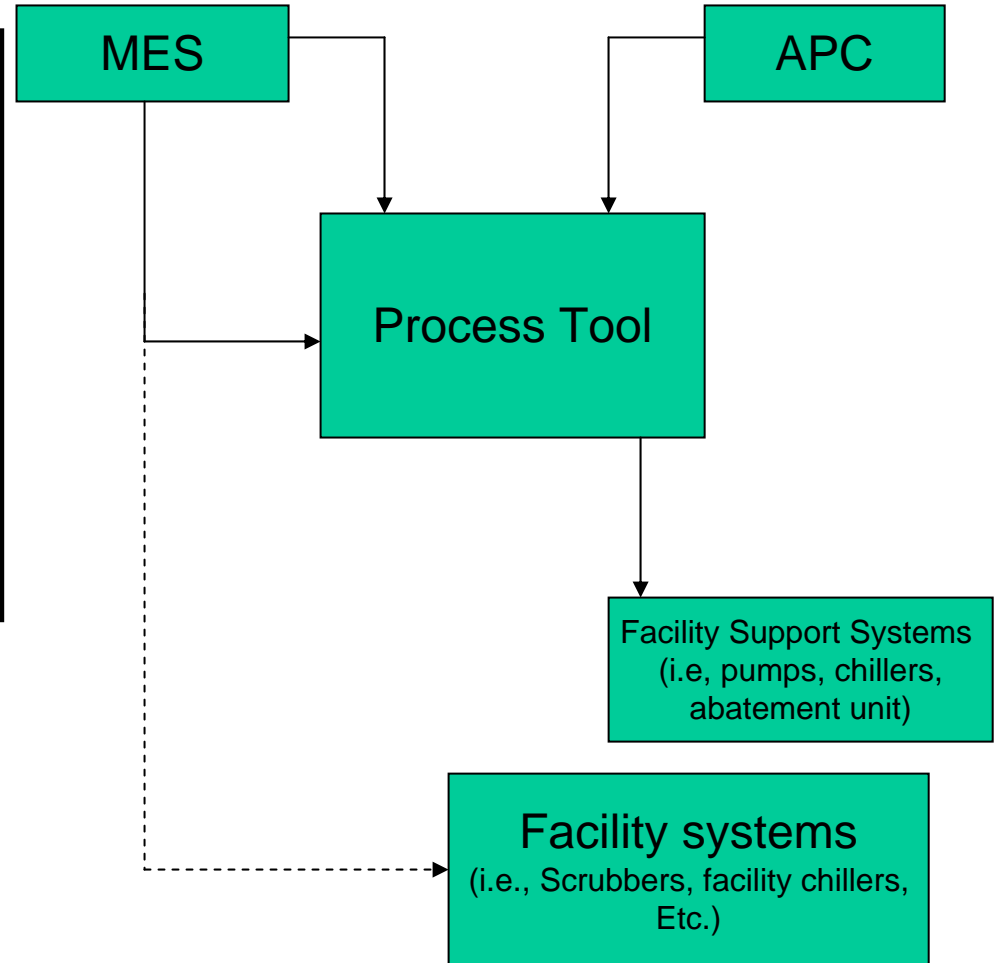
Energy conservation/ Equipment Sleep Mode



GOAL: Reduce facility operation cost by enabling facility demand based utilization model – including energy conservation

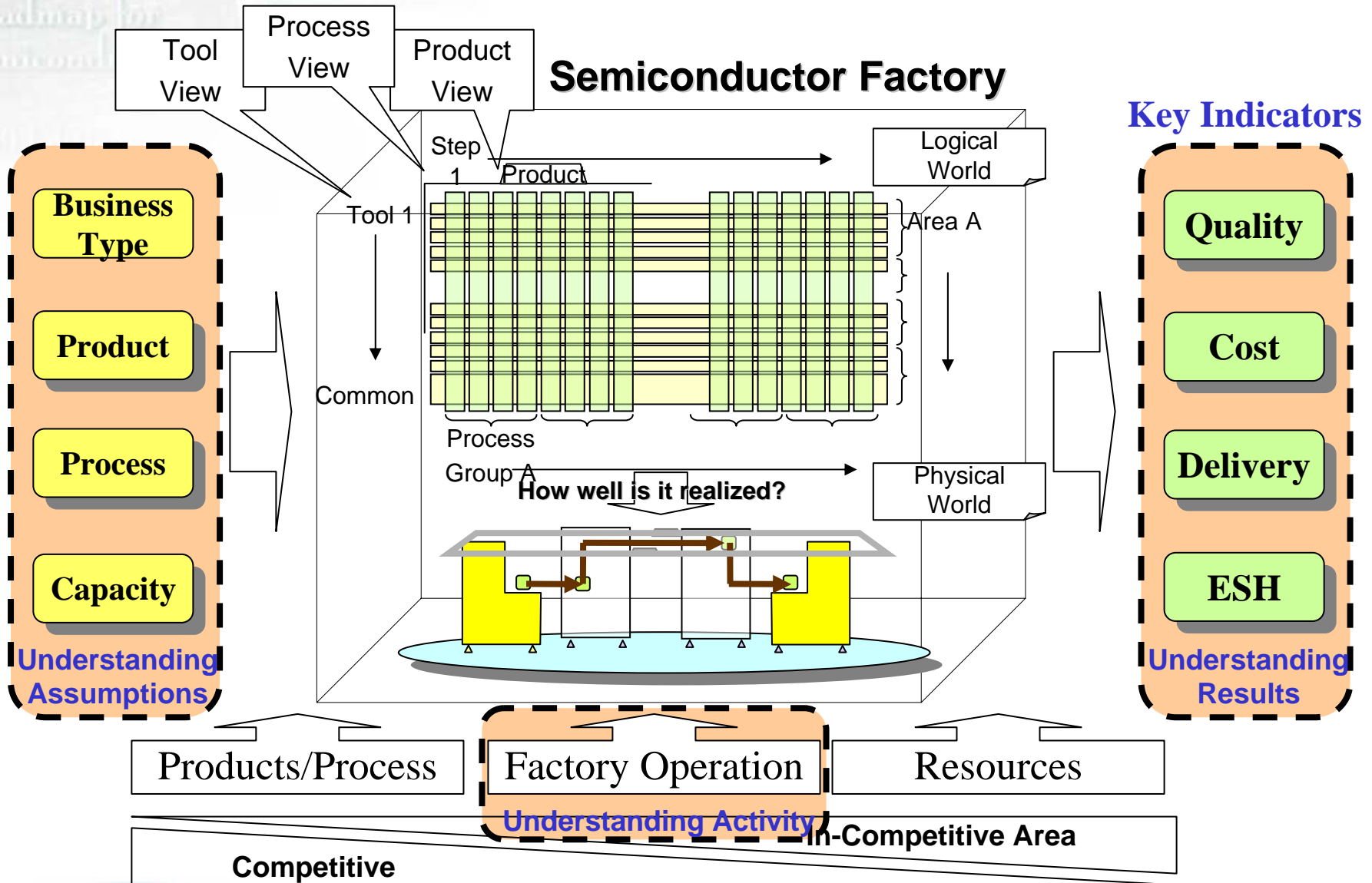
Actions for equipment energy conservation

- Enable support component 'idle mode' when tool in not processing
- Identify potential tool types (i.e., Dielectric, metals, dry etch, diffusion, etc.)
- Identify capability on existing tool sets (using SEMI E54.18) and develop a pilot
- Define potential savings
- Define plans for integrating fab MES and facility systems



Courtesy: Factory Facilities

Factory Visualization Metrics



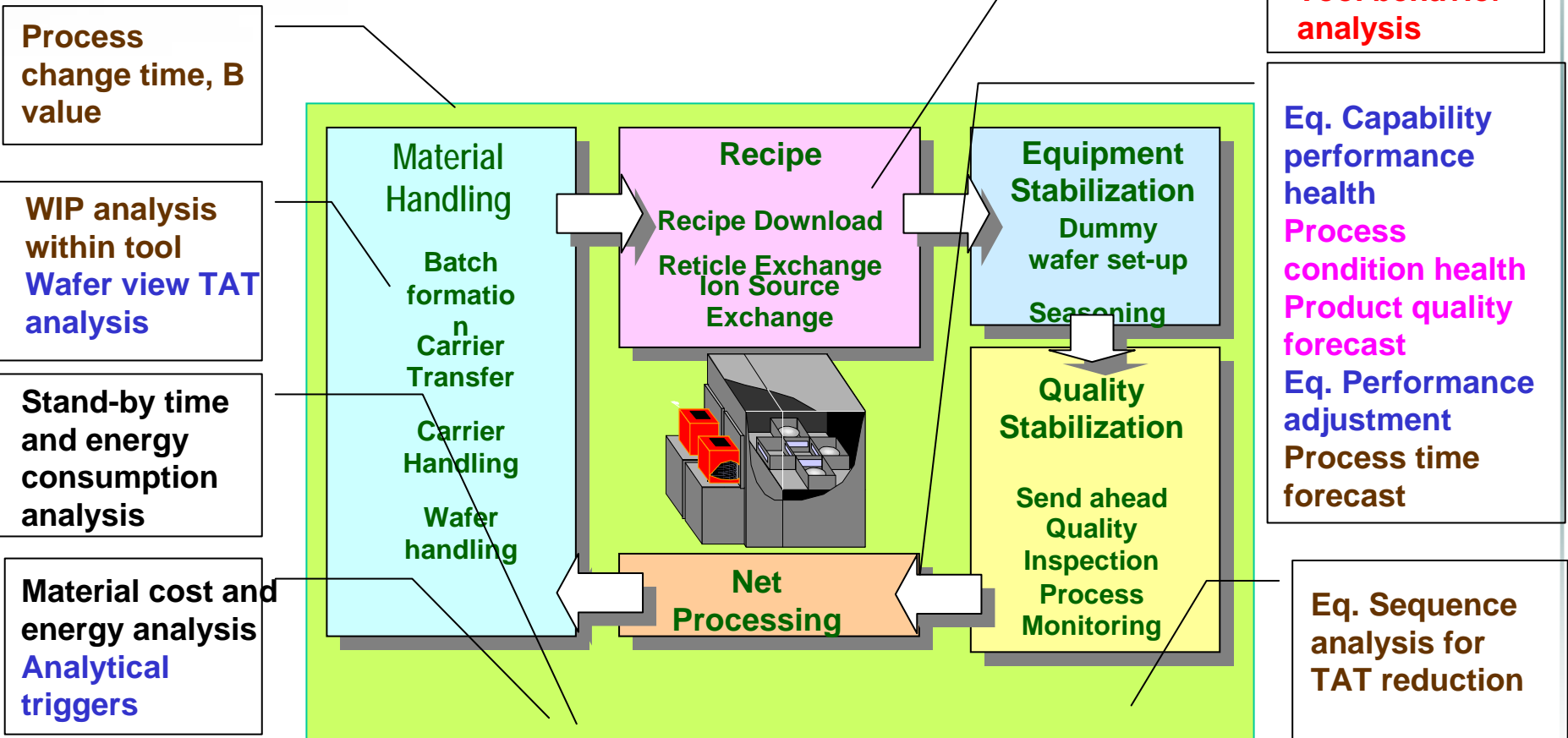
GOAL: Provide measurable/actionable metrics for managing factory at various levels easily

Courtesy: STRJ

An Example of Equipment Visualization

- Host-view equipment behavior
- OEE / Agility
- Eq. capability activities

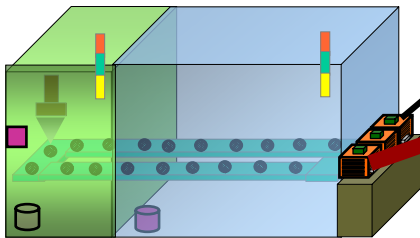
- Process conditions
- Energy and material consumption



Courtesy: STRJ

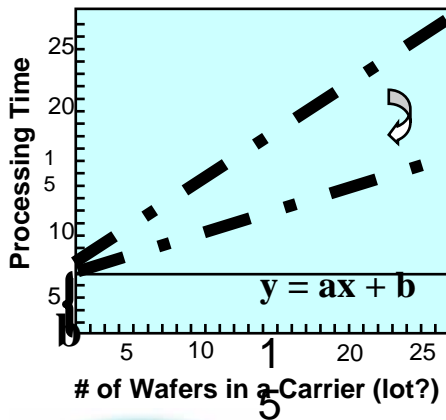
Enhance Visibility of Equipment Activity

- ★ The 2nd port is intended to provide information as described in EEC Guidelines
 - ☞ Use of the 2nd port data has not been addressed other than in EEC Guidelines
- ★ FI is working on putting the 2nd port requirements in ITRS tables
 - ☞ Required for data contents meeting the equipment performance needs
 - ☞ Required for enhanced equipment quality management and assurance

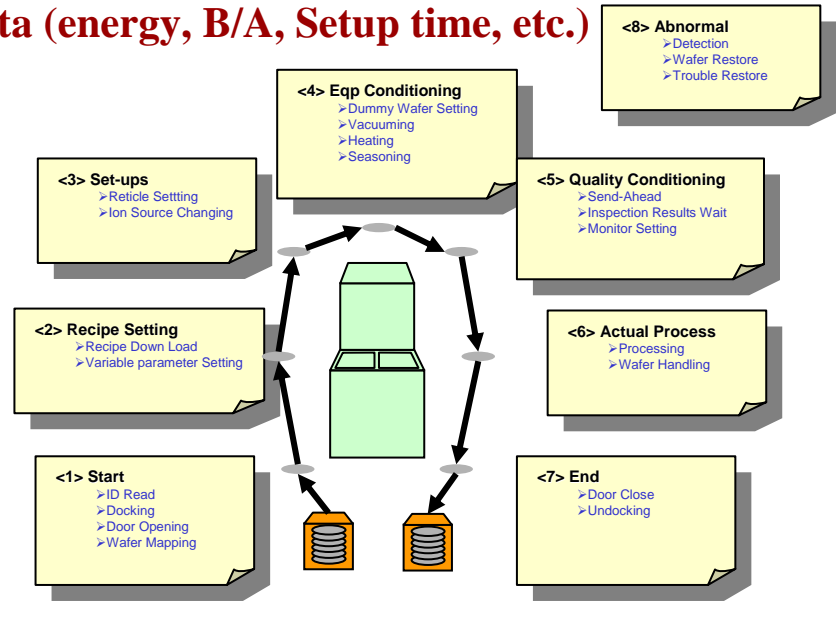


SECS data port exist – raw data

2nd data port requested → model based data + activity/event data (energy, B/A, Setup time, etc.)



setup time contributors

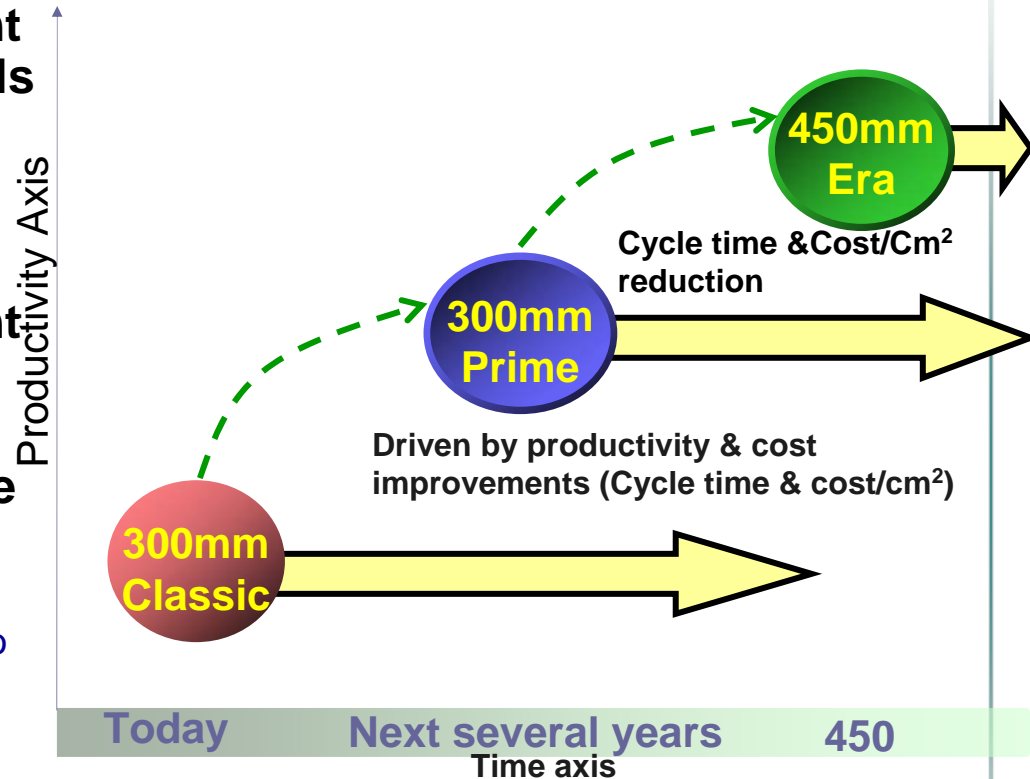


Courtesy: STRJ



Productivity Improvement Roadmap drivers

- **Comprehend the needs of different IC maker/Foundry business models**
 - These models (including high mix) will influence current 300mm configurations before transition to 450mm occurs
- **300 Prime will close the gaps identified in current 300 equipment**
 - New capabilities extendible to 450
- **450mm transition can be a simplified scale-up from 300 Prime**
 - Compared to 200mm → 300mm transition
 - Extending 300mm capability to 450mm
 - Minimizing the number of configurations to develop, test and deploy
- **Global participation is very important to define requirements, priorities and due dates**



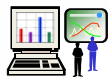
**Key drivers are significant cycle time and cost/cm² reduction
→ Productivity Improvements**



What is needed for 450mm transition



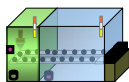
Scope/Timeline will be sync'd with ISMI 450mm program



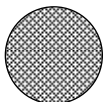
Factory Control System Standards



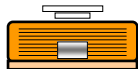
Direct Transport Standards



Production Equipment Standards

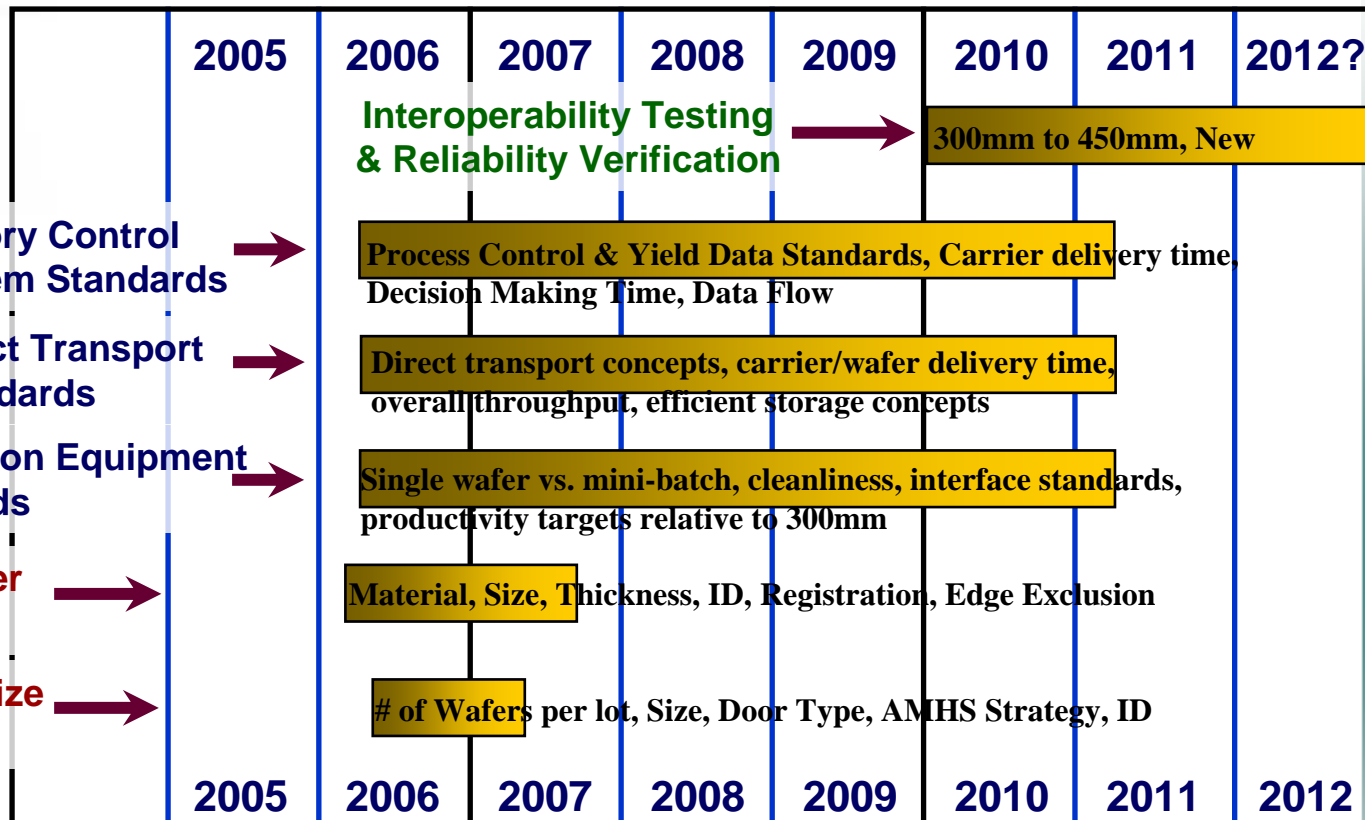


450mm wafer Standards



Carrier & lot-size determination

Bottom Opening Pod?



Many technology issues in 300Prime/450mm need to be addressed!
 FI is working with ISMI 300Prime/450mm Program to be in-sync.
 Need to Sync. with IRC on 2012 interception point



FI Cross Cut Issues to be addressed

<i>Crosscut Area</i>	<i>Factory integration related key challenges</i>
Front end Process (FEP)	SWP/Batch/Mini-batch for thermal processes (for 450mm) – proposal is to create initial process template and form a small cross-cut team. No solution exists for 1.5mm WEE, may have to revert to 2mm and target 1.5mm for 300' (~2008)
Litho	EUVL (power, consumables, weight) impact on FI and FI will provide facility weight threshold to Litho; Need to coordinate YE inputs on wafer quality (temp & humidity). Product/process centric mask metrics are in the Litho tables but many others mask related metrics need to be addressed.
ESH	ESH/FI to identify which tools are ideal candidates for equipment sleep mode (may be phased implementation) and ESH to incorporate sleep mode metric in their 2007 tables for energy conservation. ESH/FI to define boundary conditions jointly.
Metrology	Temperature & Humidity specs for Metrology tools. Off-line/in-line/in-situ Metrology will be included in the 2007 chapter (Wafer metrology versus Sensors data). FI to provide input on off-line/in-line/in-situ document and will work with IMA to sync.
Yield Enhancement	YE decided to include temperature and humidity metrics with FI referencing these tables. YE working with FI & ESH on developing a feasibility study on equipment sleep mode to conserve energy.



Factory Integration 2006 Summary and 2007 Plan

- ★ **Business strategies, market demands, and process technology changes continue to make factories difficult to integrate**
- ★ **Minor updates made to technology requirements tables and focus areas**
- ★ **Review and update technology requirements/potential solutions tables**
 - ☞ **Operations, Equipment, AMHS, FICS and Facilities**
- ★ **Add small lot size metrics to the Factory Integration Technology Requirements table**
 - ☞ **Cycle time per mask layer in Factory Operations**
- ★ **Focus on converting energy conservation to requirements/metrics**
 - ☞ **Equipment sleep mode metrics for pumps, chillers, etc.**
 - ☞ **Evaluate fab MES and facility systems integration**
- ★ **Work on the identified key focus areas and cross-cut issues**
 - ☞ **Need for 2nd data port for driving down equipment losses and better visibility**
 - ☞ **Technology requirement drivers for 300Prime/450mm**
 - ☞ **With FEP, Litho, Metrology, Yield Enhancement and ESH**
 - ☞ **EUVL, single wafer processing, IM, energy conservation, etc.**
- ★ **Address technology requirements as applicable to 300Prime/450mm**
 - ☞ **Understand timing, technology requirements, cross-cut issues, etc.**
 - ☞ **Work with ISMI/MTF to develop high level requirements roadmap**
- ★ **Work with other forums/WG to ensure synergy**
 - ☞ **ISMI 450mm WG, STRJ, IMA, SEMI, etc.**
 - ☞ **Improve sub-team participation to obtain cross-synergy**

Thanks!



Backup



Factory Operations Technology Requirements

	Near-term								Long-term							
Year of Production	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
DRAM % Pitch (nm) (contacted)	70	65	57	50	45	40	35	32	28	25	22	20	18	16	14	
Wafer Diameter (mm)	300	300	300	300	300	300	300	450	450	450	450	450	450	450	450	
Non-hot lot (average of 94% lots)																
Cycle time per mask layer (days)	1.5	1.5	1.5	1.4	1.4	1.2	1.2	1.2	1.13	1.13	1.13	1.05	1.05	1.05	1.05	
X-Factor [1]	3.1	3.1	3.1	3.05	3.05	3.05	3.05	3.05	3.05	3.05	3.05	3	3	3	3	
Hot lot (average top 5% of lots)																
Cycle time per mask layer (days)	0.55	0.55	0.55	0.51	0.51	0.47	0.47	0.47	0.44	0.44	0.44	0.39	0.39	0.39	0.39	
X-Factor [1]	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1	
Super hot lot (average top 1% of lots)																
Cycle time per mask layer (days)	0.32	0.32	0.32	0.31	0.31	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	
High-mix capacity degradation	10%	8.33%	6.67%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	
Bottleneck equipment [2] [3]																
Utilization	92%	92%	92%	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%	94%	
Availability	94%	94%	94%	96%	96%	96%	96%	96%	96%	96%	96%	96%	96%	96%	96%	
Wafer layers/day/head count	61	61	61	67	67	73	73	73	81	81	81	89	89	89	89	
Number of lots per carrier (high mix) [4]	Multiple	Multiple	Multiple	Multiple	Multiple	Multiple	Multiple	Multiple	Multiple	Multiple	Multiple	Multiple	Multiple	Multiple	Multiple	
Facilities cycle time (months)																
1st tool to 1st full loop wafer out	3	3	2.5	2.5	2.5	2	2	2	1.5	1.5	1.5	1	1	1	1	
Node -to-node change-over (weeks)	12	12	12	11	11	10	10	10	9.5	9.5	9.5	9	9	9	9	
Floor space effectiveness	1x	1x	1x	1x	1x	1x	1x	1x	1x	1x	1x	1x	1x	1x	1x	
Average number of wafers between reticle changes	35	30	25	20	20	20	20	20	15	15	15	13	13	13	13	

Key Objectives: Speed & Flexibility

1) Reduce mfg cycle times, 2) Improve Equipment Utilization, 3) Reduce Losses from High Mix

Solution exists
 Solution being developed
 Solution required



Production Equipment Technology Requirements

Year of Production	Near-term								Long-term							
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
DRAM λ Pitch (nm) (contacted)	70	65	57	50	45	40	35	32	28	25	22	20	18	16	14	
Wafer Diameter (mm)	300	300	300	300	300	300	300	450	450	450	450	450	450	450	450	
Throughput improvement (run-rate) per year	4%	New base	4%	4%	New base	4%	4%	>0%	4%	4%	4%	4%	4%	4%	4%	
New non-product wafers (NPW) as a % of wafer starts per week	<13%	<12%	<11%	<11%	<11%	<10%	<10%	<10%	<9%	<9%	<9%	<9%	<9%	<9%	<9%	
Overall NPW activities versus production wafers activities	10%	7%	7%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	
% capital equipment reused from previous node	>90%	>90%	>90%	>90%	>90%	>90%	>90%	Limited	Limited	>70%	>70%	>70%	>70%	>70%	>70%	
Wafer edge exclusion	2mm	1.5mm	1.5mm	1.5mm	1.5mm	1.5mm	1.5mm	1.5mm	1.5mm	1.5mm	1.5mm	1.5mm	1.5mm	1.5mm	1.5mm	
Equipment lead time from setup to full throughput capable	4 wks	4 wks	4 wks	4 wks	4 wks	4 wks	4 wks	4 wks	4 wks	4 wks	4 wks	4 wks	4 wks	4 wks	4 wks	
Process equipment availability (A80)	92%	>92%	>94%	>95%	>95%	>95%	>95%	>95%	>95%	>95%	>95%	>95%	>95%	>95%	>95%	
Metrology equipment availability (A80)	96%	96%	>96%	>97%	>98%	>98%	>98%	>98%	>98%	>98%	>98%	>98%	>98%	>98%	>98%	
Intrinsic setup time reduction, vs. base	6%	10%	12%	12%	15%	15%	17%	17%	> 17%	> 17%	>20%	>20%	>20%	>20%	>20%	
Ability to run different recipes and parameters for each wafer	Partial	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
248 nm lithography scanner productivity (wafers outs per week per tool)	7400	7700	7700	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	
193 nm lithography scanner productivity (wafers outs per week per tool)	5300	5600	5600	6000	6000	6000	6000	6300	6300	6500	6500	6500	6500	6500	6500	
Maximum allowed electrostatic field on wafer and mask surfaces (V/cm)	80	70	63	55	50	44	38	35	31	28	25	22	20	18	15	

Key Objectives: 1) NPW reduction, 2) Reliability Improvement, 3) Run rate (throughput) improvement → Productivity & Cost

□ Solution exists ◻ Solution being developed ■ Solution required



Material Handling Technology Requirements

Year of Production	Near-term								Long-term						
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
DRAM ½ Pitch (nm) (contacted)	70	65	57	50	45	40	35	32	28	25	22	20	18	16	14
Wafer Diameter (mm)	300	300	300	300	300		450	450	450	450	450	450	450	450	450
Transport E-MTTR (minutes) per SEMI E10	10	10	10	10	10	10	5	5	5	5	5	5	5	5	5
Storage E-MTTR (minutes) per SEMI E10	25	20	20	20	20	20	20	20	20	15	15	15	10	10	10
Transport MMBF	11,000	15,000	25,000	35,000	35,000	35,000	45,000	45,000	45,000	55,000	55,000	55,000	65,000	65,000	65,000
Storage MCBF	35,000	45,000	55,000	60,000	60,000	60,000	70,000	70,000	70,000	80,000	80,000	80,000	100,000	100,000	100,000
Peak system throughput (40K WSPM)															
Interbay transport (moves/hour)	2250	2575	2660	2660	2660	2660	2660	2660	2660	2660	2660	2660	2660	2660	2660
Intrabay transport (moves/hour) — high throughput bay	250	270	280	290	300	300	300	300	300	300	300	300	300	300	300
Transport (moves/hour)—unified system	4740	4900	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
Stocker cycle time (seconds) (100 bin capacity)	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Average delivery time (minutes)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Peak delivery time (minutes)	12	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Hot lot average delivery time (minutes)	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2
AMHS lead time (weeks)	12	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8	<8
AMHS install time (weeks)	24	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Downtime to extend system capacity when previously planned (minutes)	120	<15	<15	0	0	0	0	0	0	0	0	0	0	0	0
Time required to integrate process tools to AMHS (minutes per LP)	15	12	10	10	5	5	5	5	5	5	5	5	5	5	5

Key Objectives: 1) Increase throughput for Traditional and Unified Transport, 2) Reduce Average Delivery times, 3) Improve Reliability

□ Solution exists ■ Solution being developed ■ Solution required



FICS Technology Requirements

	Near-term								Long-term						
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
<i>Year of Production</i>	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
<i>DRAM ½ Pitch (nm) (contacted)</i>	70	65	57	50	45	40	35	32	28	25	22	20	18	16	14
<i>Wafer Diameter (mm)</i>	300	300	300	300	300		300	450		450	450		450	450	450
Availability of mission critical applications (% per year)	99.986	99.987	99.99	99.991	99.991	99.994	99.994	99.994	99.999	99.999	99.999	99.999	99.999	99.999	99.999
Downtime of mission critical applications (minutes per year)	75 min	75 min	68 min	53 min	45 min	30 min	30 min	30 min	8 min	8 min	8 min	4 min	4 min	4 min	4 min
Factory down due to unscheduled FICS downtime due to FICS (minutes per year)	120 min	90 min	90 min	60 min	60 min	61 min	60 min	60 min	30 min	30 min	15 min	15 min	15 min	15 min	15 min
Full factory down due to unscheduled FICS downtime (minutes per year)	60 min	60 min	60 min	<15 min	<15 min	<15 min	<15 min	<15 min	<15 min	<15 min	<15 min	<15 min	<15 min	<15 min	<15 min
Factory down due to scheduled FICS downtime (minutes per year)	180 min	180 min	120 min	120 min	120 min	60 min	60 min	60 min	0 min	0 min	0 min	0 min	0 min	0 min	0 min
Full factory down due to scheduled FICS downtime (minutes per year)	180 min	180 min	120 min	120 min	120 min	60 min	60 min	60 min	0 min	0 min	0 min	0 min	0 min	0 min	0 min
Mean time to recover for mission critical applications (minutes down per year)	15	<15	<15	<15	<15	<15	<15	<15	5	5	5	2	2	2	2
MCS design to support peak number of AMHS transport moves (moves/hr)	14.2K	14.7K	15K	15K	15K	15K	15K	15K	15K	15K	15K	15K	15K	15K	15K
FICS design to support peak number of AMHS direct transport moves (moves/hr)	1420	1470	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500
Time to send and load tape-out data into mask shop data system (hours)	6-12	6-12	6-12	6-12	6-12	6-12	6-12	6-12	6-12	6-12	6-12	6-12	6-12	6-12	6-12
Time for OPC calculations and data preparation for mask writer (days)	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8	4-8
Time for OPC calculations only (days)	3-6	3-6	3-6	3-6	3-6	3-6	3-6	3-6	3-6	3-6	3-6	3-6	3-6	3-6	3-6
% Factory information and control systems reusable for next node	>93%	>93%	>93%	>93%	>93%	>93%	>93%	>93%	>93%	>93%	>93%	>80%	>80%	>80%	>80%
Ability to run/adjust different recipes/parameters within a run	Partial	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wafer-level recipe/parameter adjustment	Partial	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Within-wafer recipe/parameter adjustment	Partial	Partial	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Key Objectives: 1) Increase Reliability, 2) Increase Factory Throughput, 3) Reduce or Maintain Mask Shop Cycle Time, 4) Reduce Costs

□ Solution exists ◻ Solution being developed ■ Solution required



Facilities Technology Requirements



Year of Production	Near-term								Long-term							
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
DRAM % Pitch (nm) (contacted)	70	65	57	50	45	40	35	32	28	25	22	20	18	16	14	
Wafer Diameter (mm)	300	300	300	300	300	300	450	450	450	450	450	450	450	450	450	
Manufacturing (cleanroom) area/wafer starts per month (m ² /WSPM) (low mix only)	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	
SubFab to Fab ratio	1	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	
Facility service life (in three-year nodes)	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Facility cleanliness level (ISO 14644) [1]	Class 6	Class 6	Class 6	Class 6	Class 6	Class 6	Class 7	Class 7	Class 7	Class 7	Class 7	Class 7	Class 7	Class 8	Class 8	
Facility cleanliness level (Airborne molecular contamination AMC) - ppt M	<i>Discussed in Yield Enhancement Tables</i>															
Facility critical vibration areas (lithography, metrology, other) (micrometers per second) [2]	6.25 (VC D)	6.25 (VC D)	6.25 (VC D)	6.25 (VC D)	6.25 (VC D)	6.25 (VC D)	6.25 (VC D)	6.25 (VC D)	6.25 (VC D)	6.25 (VC D)	6.25 (VC D)	6.25 (VC D)	6.25 (VC D)	6.25 (VC D)	6.25 (VC D)	
Facility non-critical vibration areas (micrometers per second) [2]	50 (VC A)	50 (VC A)	50 (VC A)	50 (VC A)	50 (VC A)	50 (VC A)	50 (VC A)	50 (VC A)	50 (VC A)	50 (VC A)	50 (VC A)	50 (VC A)	50 (VC A)	50 (VC A)	50 (VC A)	
Maximum allowable electrostatic field on facility surfaces (V/cm)	80	70	63	55	50	44	38	35	31	28	25	22	20	18	15	
Gas, water, chemical purity	<i>Discussed in Yield Enhancement Chapter</i>															
Factory construction time from groundbreaking to first tool move-in (months)	9	9	9	8	8	9	9	9	9	9	8	8	8	8	8	
Production equipment install and qualification cost as a % of capital cost	8%	7%	7%	6%	6%	5%	8%	8%	8%	7%	7%	6%	6%	5%	5%	
Facility operating cost (including utilities) as a % of total operating cost	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	
Utility cost per total factory operating cost (%)	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	
Power, water, and chemical consumption	<i>Discussed in ESH Chapter</i>															
Energy Consumption Total Fab Support System (kWh/cm ² per wafer out)	0.55	0.55	0.50	0.50	0.45	0.40	0.50	0.50	0.50	0.45	0.45	0.40	0.40	0.35	0.35	

Key Objectives: 1) Factory Extendibility, 2) AMC, 3) Rapid Install/Qualification, 4) Reduce Costs

□ Solution exists ■ Solution being developed ■ Solution required

