Scheduler/Dispatcher User Requirements

International SEMATECH
Technology Transfer # Project MET202-Draft

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International SEMATECH
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Abstract: The challenge of processing 300 mm semiconductor wafers involves increased levels of automation for many factory systems. In order to coordinate those activities, an intelligent capability for scheduling and dispatching activities involving many resources must be provided. 300 mm factory scheduler/dispatcher software software must support coordinated scheduling and dispatching of factory activities that involve both the processing and transport of materials. It must also coordinate planned and unplanned maintenance of equipment and durable resources. Scheduling constraints imposed by mixed lot carriers and wafer-level processing for 300 mm wafers must also be comprehended. This document defines the user requirements for the functionality of a scheduling and dispatching capability with focus areas on production optimization, material transport optimization, equipment optimization, and associated reporting and simulation of factory activities.

Keywords: Specifications, Planning, Scheduling

Authors: Karl Gartland (IBM), Gary Godding (Intel), Bob Hodges (Texas Instruments), Nihal Muzumbar (Intel), Shinichi Hohkibara (Toshiba), Satoshi Kono (Fujitsu), Michio Honma (NEC), Giichi Inoue (Toshiba)

Approvals: Margaret Pratt, Project Manager
Jackie Ferrell, Industry Standards Program Manager
Randy Goodall, Director, Productivity & Infrastructure
Laurie Modrey, Technical Information Transfer Team Leader

Table of Contents

List of Figures

List of Tables

1 EXECUTIVE SUMMARY

Manufacturing involves coordination of a wide variety of activities. This coordination involves management of specified manufacturing activities including ***planning*** the activities, ***scheduling*** the activities on resources, and ***dispatching*** the activities when they are due for execution. In many cases, the activities will be managed and tracked as formally specified jobs within the Manufacturing Execution System (MES).

This document presents the user-level requirements for the capabilities needed to schedule and dispatch manufacturing activities within a semiconductor manufacturing plant. These requirements are intended to form a basis for the development of standards within the SEMI International Standards organization. Standards for the scheduler/dispatcher components of an MES) will enable users and suppliers of conformant software products to more easily integrate solutions that meet the requirements defined here.

1.1 Objectives

The intention of this document is to collect, document, and communicate user requirements. After reading this document, you will be able to do the following:

- Describe the vision for scheduling and dispatching automation for semiconductor manufacturing.
- Define what the users of scheduling and dispatching software products require in those products to support semiconductor manufacturing.
- Define common terms and concepts of scheduling and dispatching that are required for effective communication in requirements and standards documents.

1.2 Section Descriptions

This document consists of five sections (not including this section); each is briefly described below.

- Global Joint Guidelines References (Section 2) identifies the guideline references from the Global Joint Guidelines that are addressed by this document.
- Overview (Section 3) provides a high level overview of the scheduler/dispatcher system architecture and describes a vision for the role of the scheduler/dispatcher in a 300 mm factory.
- User Requirements (Section 4) specifies and explains the user requirements for scheduling and dispatching.

1.3 Revision History

Table 1 Revision History

Revision	Date	Updates
0.0	August 23, 1999	Initial Version
0.1	August 27, 1999	Updates from VC
0.2	September 7, 1999	Updates from VC
0.3	September 13, 1999	Added User Requirements Section
0.4	September 16, 1999	Reorganized document. Removed functional requirements section.
0.5	September 25, 1999	Updates from Sep 15,16 I300I/J300E Video Conference
0.6	September 27, 1999	Inputs from I300I and J300E included.
0.7	October 1, 1999	Revised for alignment of vision and requirements outline structure and to add more explanation to each requirement.
0.8	October 13,1999	Section 3.1 - Updated paragraph Revised Requirements: 4.1.13 - Update 4.1.15 - Update 4.1.18 - New 4.3.6 - Update Updated all scenarios to common format.
0.9	October 15, 1999	Modified wording of requirements for clarity in final I300I review session.
1.0	October 16, 1999	Proposed document for approval and publication after J300E review. Removed scenarios section for completion in USRD.
1.1	October 22, 1999	Updates from SEMICON/Southwest meetings.
1.2	November 1, 1999	Update wording to section 4.1.19. Added headings to section 4.1.19, 4.1.20, 4.1.21, 4.3.13

1.4 Document Contributors

Table 2 Contributors to this Requirements Document

Revision	Date	Authors
1.1	October 22, 1999	Karl Gartland (IBM), Gary Godding (Intel), Bob Hodges (Texas Instruments), Nihal Muzumbar (Intel), Shinichi Hohkibara (Toshiba), Satoshi Kono (Fujitsu), Michio Honma (NEC), Giichi Inoue (Toshiba)

1.5 Total Document Pages

This document contains 26 pages. Ensure that you have the correct number of pages by counting the title page as two pages (front and back), all front matter, the document body, any appendices, and index pages (if applicable).

1.6 Reference Documents

- *CIM Global Joint Guidance for 300 mm Semiconductor Factories: Release Four*, I300I/J300, Technology Transfer #98063534C-ENG, July 30, 1999.
- *300 mm Integrated Vision for Semiconductor Factories: Release Two*, I300I/J300, Technology Transfer #99013659B-ENG, June 18, 1999.
- *Provisional Specification for CIM Framework Domain Architecture*, SEMI E81.
- *Proposed Guide for CIM Framework Technical Architecture*, SEMI E96.
- *Provisional Specification for CIM Framework Material Transport and Storage Component*, SEMI Draft Document 2824A (Note: 2824 was balloted in June, 1999 and withdrawn for rework. It is scheduled for re-ballot as 2824A in the SEMICON Japan ballot cycle for review in December, 1999).
- *Provisional Specification for CIM Framework Global Declarations and Abstract Interfaces*, SEMI E97.
- *I300I/J300 AMHS Framework User Requirements – Version 1.0*, March 31, 1999.

2 GLOBAL JOINT GUIDELINES REFERENCES

The 300 mm scheduler/dispatcher software must be interoperable with the factory system. To achieve this goal, scheduler/dispatcher software must conform to standard functionality, framework, interfaces, and communication protocols with the factory system.

Requirements	3. International Participation is Essential.
	9. Increased Control of Factory Logistics and Production Scheduling
	11.3 Factory Automation (FA)
Standards	SEMI E81, SEMI E97. Action required for SEMI to develop and define standard interfaces for factory systems.
References	None
Recommendations	Scheduler/dispatcher and MES suppliers should be involved in the standards development.

3 OVERVIEW

3.1 System Architecture

Figure 1 illustrates the topology of the scheduling/dispatching within the overall factory automation system. Planning systems may provide input to multiple factories; however, the scheduling/dispatching system will be concerned only with optimizing the output of a single factory or multiple production lines within a factory facility.

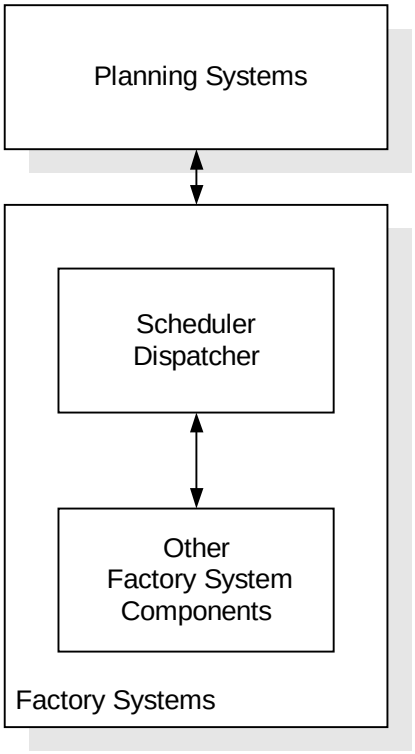

Figure 1 Scheduling/Dispatching System View

3.2 Scheduler/Dispatcher Vision

The scheduler/dispatcher will help meet on-time deliveries of product by effectively scheduling material through the factory. To accomplish this purpose, scheduler/dispatcher capabilities are needed in four areas: 1) optimization for processing a factory's work in progress (WIP); 2) optimization for delivery of all material to required locations; 3) optimization for resource utilization, particularly in working around planned and unplanned service interruptions of equipment; and 4) analysis of future situations to identify opportunities for additional improvements. Stated simply, the scheduler/dispatcher must answer questions like "What is next for an equipment?," "Where should a carrier be delivered?," or "When should equipment be maintained?".

A description of each area is given below along with a reference to the appropriate section in the user requirements.

3.2.1 Material Scheduling

Factories will process all lots using a scheduler/dispatcher system to optimize factory commitments as supplied by the enterprise and factory planning systems. The scheduler's start policy may be more reactive to the current state of the factory than the planned releases. For instance, it may either pull in or push out planned starts of product substrates to optimize factory loading.

The scheduler/dispatcher can control all non-product substrates released in the factory (e.g., monitor, test, and dummy wafers). The scheduler/dispatcher will be able to automatically start non-product substrate into the factory when product starts or factory usage necessitates it.

The scheduler/dispatcher will be able to take manufacturing constraints into account when scheduling WIP through the factory. One examples of this would be the coordination of reticle usage to WIP processing requirements. Another example would be the coordination of WIP levels and planned equipment maintenance in a particular manufacturing area.

The scheduler/dispatcher will be able to support interfaces to enable the factory to run in a fully automated mode, advisory mode or both. In advisory mode, the output of the scheduler/dispatcher would be available for factory personnel to act upon. In fully automated mode, the output of the scheduler/dispatcher would be available to the automated factory control systems.

Detailed statements of requirements relating to material scheduling are included in Section 4.1.

3.2.2 Material Delivery

The scheduler/dispatcher will be able to schedule delivery for all material and durables within the factory. For automated material handling systems (AMHS) that support delivery directly to the equipment load port, the scheduler/dispatcher will be able to schedule and dispatch activities that enable automated delivery. The scheduler/dispatcher will also be able to use information on predicted delivery times to effectively coordinate WIP processing goals with material delivery times to the extent that such information is available from the AMHS.

Detailed statements of requirements relating to material scheduling are included in Section 4.2.

3.2.3 Equipment Scheduling

The scheduler/dispatcher will be able comprehend and manage the constraints and opportunities imposed by the factory equipment. This includes items such as equipment maintenance, equipment capabilities (multi-lot batch capabilities, cascading, etc.), and equipment limitations.

Detailed statements of requirements related to material scheduling are included in Section 4.3.

3.2.4 Analysis/Reporting

The scheduler/dispatcher will comprehend and appropriately provide supporting capabilities and “what if” analysis (potentially offline) systems. The systems would be used to monitor and optimize the performance of the scheduler/dispatcher system.

Detailed statements of requirements related to material scheduling are included in Section 4.4.

4 USER REQUIREMENTS

The following requirements statements specify **what** is needed in a scheduler/dispatcher capability, but do not attempt to constrain or specify **how** those capabilities will be achieved.

4.1 Processing Optimization Requirements

This section addresses the user requirements for scheduling and dispatching material to equipment for processing. It covers requirements related to management of WIP and the process operations that are to be performed on the material.

4.1.1 Allocate Lots to Equipment

Recommend lots to be processed at specific equipment or group of equipment. Alternatively recommend equipment to process specific lots.

4.1.2 Manual Overrides

Enable manual overrides that supercede recommendations generated for material processing.

There may be cases where a human determines that reasons outside of the control or visibility of the scheduler/dispatcher warrant a schedule or dispatch recommendation to be overridden. This type of manual override will require the scheduler/dispatcher to readjust its schedule with that override treated as a fixed element not subject to change. Allowing such manual overrides enable human decision-makers to work through the scheduler/dispatcher for exceptions rather than working around it or circumventing its scheduling process.

4.1.3 Rules for Scheduling/Dispatching

Provide support for specification and tailoring of rules and preferences that affect the way activities are scheduled.

Different enterprises and factories within an enterprise will have varying policies regarding the sort order and tradeoffs that the scheduler/dispatcher uses to make its recommendations. Interfaces that allow those rules to be specified or tailored (for example, by flag settings) can allow users to optimize the factors such as the cycle time and output volume of all products in the factory.

4.1.4 Lot Prioritization Policies

Schedule lots based on their priority, which may be determined from attributes of the lots and/or by using scheduling rules.

For example, the scheduler/dispatcher may allocate lots to equipment based on the lot’s product type, date of arrival at its operation, or computation of its critical ratio to meet shipping targets.

4.1.5 Hot Lot Scheduling

Schedule activities to give preference to lots with highest priority to achieve quick turn around time (QTAT).

Hot lots have their priority levels set to indicate that they need to be given preference over other lots in the factory. A hot lot should not wait in a queue behind a lot with lower priority. If a queue exists at the equipment, the hot lot should be placed at the front of the queue.

4.1.6 Substrate Scheduling

Consider all substrates, including both product and non-product substrates, when scheduling material for processing.

The scheduler/dispatcher should be able to consider all substrates in the factory while making scheduling decisions. There should be no limitation on the type of material it can comprehend in its schedule (e.g., test or monitor wafers), and they should also be included in the schedules generated.

4.1.7 Durable Availability

Consider the availability of all durables required to support scheduled activities.

The scheduler/dispatcher should determine the durables required for processing (e.g., FOUPs, reticles, probe cards, load boards) and take their availability into consideration when scheduling material for processing. If there are any constraints on availability of durables, these constraints should be reflected in the scheduler recommendations.

4.1.8 Omission of Inspection Step

Omit inspection steps for a given lot based on rules and/or external input.

The scheduler/dispatcher system should be responsible for generating any recommendation regarding omission of a step. It may do this either internally, if it has all the data and rule logic necessary to make the recommendation, or it may obtain the data and/or decision from an external system.

4.1.9 Monitor/Test Wafer Starts

Automatically start monitor/test wafers based on inventory trigger levels.

For example, the scheduler/dispatcher may need to comprehend that the factory requires a 10K test wafer inventory at any given time. Based on its knowledge of the factory, it should be able to schedule more or less test wafers to maintain that level.

4.1.10 Dummy Wafer Starts

Automatically start dummy wafers driven by run-based usage.

The scheduler/dispatcher should be able to add dummy lots into the factory based on usage limits and data for existing dummy wafers.

4.1.11 Send Ahead Wafers

Schedule send-ahead wafers when required.

The scheduler/dispatcher should be able to schedule activities, split a lot, process a single send-ahead wafer from the lot, and inspect the wafer. Depending on inspection results, it may need to schedule activities to process the remainder of the lot and merge the wafers back into a single lot.

4.1.12 Lot Specific Variations in Processing

Schedule activities for specific lots that require “special” processing outside the normal process flow.

The scheduler/dispatcher may need to schedule special activities for a lot within the normal process flow. For example, an inspection step might be added to the process flow for a specific lot.

4.1.13 Processing Time Constraints

Schedule production activities on a lot within constrained elapsed time limits between operations.

For example, the scheduler/dispatcher must handle “time critical windows,” such as the time between diffusion pre-cleans and diffusion processing steps. A specific lot’s priority may need to be raised at the diffusion station to assure it is processed before its time limit expires.

4.1.14 Multiple Lots in a Carrier

Coordinate scheduling of lots for processing and carriers for transport when multiple lots are contained in a single carrier.

When multiple lots are transported in a single carrier, the scheduler/dispatcher must coordinate the lot-level scheduling of process operations on production equipment and the carrier-level scheduling of transport between factory locations. The lots grouped into a carrier are assumed to share some or all of a process flow, but specific process operations on the contained lots may vary in details of settings or required durables. During the course of the process flow for a specific lot, it may be moved from one carrier to another.

4.1.15 Scheduling Engineering Experiments

Prioritize schedules to take engineering experiments and their special scheduling needs into consideration.

The scheduler/dispatcher will need to comprehend lots used in engineering experiments. The goals in engineering may not be throughput-oriented or the lots may need to be prioritized differently, use different routes, or split and merge differently from production lots. The scheduler/dispatcher will need to factor in such engineering requirements while generating the overall schedule for the factory.

4.1.16 Operation Throughput Goals

Prioritize schedule to meet throughput goals for moves through a specific operation using actual factory performance data.

The factory may set goals for attaining target throughput levels at specific operations. If these goals are established, the scheduler/dispatcher may adjust schedules to improve the attainment of the goals.

4.1.17 Adjustment to Compensate for Schedule Delta

Prioritize schedules to minimize deltas between predicted progress of lots through their process flows and actual completion of process operations.

By determining the delta between predicted progress through a process flow and the actual status of a lot, the scheduler/dispatcher may be able to adjust priorities or dispatching decisions to minimize such deltas. For example, when a lot has fallen behind its predicted schedule, it may be given preference over other lots that are on or ahead of schedule.

4.1.18 Coordination of PMs with WIP Scheduling

Schedule material processing or movement to storage to minimize impact of scheduled maintenance.

The scheduler/dispatcher should be able to comprehend scheduled maintenance on all equipment to optimize WIP flows through any given manufacturing area.

4.1.19 WIP and Equipment Coordination

Coordinate speed of WIP flows with equipment states.

The scheduler/dispatcher should be able to comprehend the states of all equipment to control WIP progress. If *Equipment A* is in trouble and many lots are queuing for this equipment, then some lots that are supposed to be processed by this equipment in the near future should not be progressed at the upstream steps. For the other stations, the scheduler/dispatcher should dispatch the lots that do not have *Equipment A* processing step in the process flow or will not go to *Equipment A* soon.

4.1.20 Bottleneck Flow Control

Schedule activities to maximize throughput at bottlenecks.

The scheduler/dispatcher may comprehend beforehand what areas are bottlenecks by capacity analysis. For example, a bottleneck might not have lots available due to some troubles in another area. In general, the bottleneck should not be idle at any time to maximize total throughput on the factory. The scheduler/dispatcher will have to feed lots to the bottleneck by prioritizing lots at the upstream steps.

4.1.21 Unexpected Lot Events

Respond to unexpected lot events.

Reschedule affected activities when unexpected lot events impact previous schedule or dispatch decision. If the lot that is scheduled to process in *Equipment A* is in trouble (rework, scrap, broken) at a upstream step, rescheduling will be needed because the lot cannot make it at the predicted time.

4.2 Delivery Optimization Requirements

This section specifies user requirements that apply to scheduling or dispatching the delivery of material to locations within the factory. The delivery of material will involve both the automated transport with the services of AMHS and manual transport. In most cases, delivery will act on material containers rather than directly on the contained material.

4.2.1 Delivery to Equipment Load Port

Schedule material delivery to the equipment load port.

The material delivery may involve the load port of the source or the destination equipment for the delivery. Based on the type of equipment, there could be variations in whether the delivery is directed to the equipment as a whole or to a specific port on the equipment. For example, knowledge of the source port is required for fixed buffer equipment, but optional for other types of equipment. Similarly, the destination port is required for fixed buffer equipment, but left unspecified for delivery to internal buffer production equipment. Finally, some knowledge of port reservations may be required of the scheduler to optimize deliveries where ports must be reserved in advance of the delivery.

4.2.2 Scheduling Based on Transport Time Estimates

Incorporate knowledge of transport times in schedules.

Predictive estimates of transport times for material delivery is needed to allow the scheduler to optimize time critical operations that depend on material delivery between the time sensitive operations. Note that accurate prediction of transport times may or may not be supported by the AMHS. Estimates of transport time may need to be derived from historical data or other sources supporting prediction heuristics.

4.2.3 Coordinated Delivery for Batch Processing

Schedule coordinated delivery of all material included in a batch process operation.

The scheduler/dispatcher will need to coordinate delivery so that all required material arrives at the destination equipment within a specified time window for the batch operation.

4.2.4 Coordinated Transport of Substrates and Durables

Coordinate delivery schedule for all transportable items required for a process operation.

The scheduler/dispatcher may need to schedule deliveries for both the substrates to be processed (e.g., wafers) and the durables required for processing (e.g., reticle) to ensure that all required items arrive at the process equipment in a timely fashion.

4.2.5 Determining Next Destination

Determine the next equipment for the lot when it finishes current processing.

The scheduler/dispatcher must be able to determine the next destination for the material to allow scheduling of the delivery resources required to transport it to that destination. The destination could be either production equipment or storage equipment. If delivery to storage equipment is required, the capacities of that equipment to hold the type of material being delivered may need to be considered. Alternative delivery destinations may be required if capacity or load port reservations preclude delivery to the primary destination.

4.2.6 Delivery to Optimal Location

Schedule delivery of material to a better storage location to minimize future delivery time to the next production equipment destination.

The scheduler/dispatcher may need to schedule a movement of material to optimize storage or future delivery times to the next equipment. This situation might be caused by selection of an alternative storage location due to limited storage capacity in the first choice of stocker. Such an interim delivery would position the material closer to minimize the transport time when delivery of the material to production equipment is scheduled to occur.

4.2.7 Relocation when Destination Changes

Schedule delivery of material to a better storage location to minimize future delivery time when the next production equipment destination changes.

The scheduler/dispatcher may need to schedule a movement of material to a new storage location that is closer to different equipment than was originally targeted as the next destination. This situation might be caused if the production equipment identified for the next process operation on the material were to go out of service due to some unplanned event.

4.3 Equipment Scheduling Requirements

This section specifies the user requirements for the management and optimization of manufacturing equipment within the factory. The scheduler/dispatcher must manage equipment effectively to prevent factory bottlenecks, maximize equipment utilization, and optimize product yield. This implies the scheduler/dispatcher must consider equipment PMs, equipment material processing policies, and any special flows to ensure high yields.

4.3.1 Schedule Equipment Maintenance

Schedule equipment maintenance activities

The scheduler/dispatcher should be able to coordinate equipment maintenance with other factory operations.

4.3.2 Usage Based Equipment Maintenance Scheduling

Schedule equipment maintenance activities based on rules, data, and external events.

For example, PM activity could be triggered when equipment usage has passed a threshold value. Examples of thresholds could be number of wafers processed, time since last PM, or number of processing minutes that have elapsed.

4.3.3 Optimizing PMs by Opportunity

Adjust timing of PM schedules if an opportunity is detected.

An opportunity could occur when there is no WIP available, the equipment is idle, or the equipment has gone out of control. The PM activity could be completed at this time, potentially making the equipment available when it will be needed for production.

4.3.4 Optimize Equipment Usage Towards PM Schedules

Adjust priorities for the usage of equipment to optimize the time when a scheduled PM is due.

Scheduler/Dispatcher should be able to prioritize/de-prioritize the usage of an equipment to influence when a PM is due. De-prioritizing the equipment would effectively decrease amount of material processed on the equipment, which would delay the time when a PM is due. Prioritizing the equipment would effectively increase usage of the equipment, which would pull-in the time when the PM is due. This could be done to prevent all equipment in an area from needing a PM at the same time.

4.3.5 Responding to Unexpected Equipment Events

Reschedule affected activities when unexpected equipment events impact previous schedules or dispatch decisions.

This capability may be needed in case of equipment trouble. The scheduler/dispatcher may need to reschedule material that had been assigned to a piece of equipment that became unavailable. In addition, scheduler/dispatcher may need to adjust schedules on the other pieces of equipment to compensate for the decreased capacity of the area.

4.3.6 Optimize Equipment Utilization

Schedule activities based on special equipment policies that optimize utilization and availability for that particular type of equipment.

For multi-port equipment that supports cascading of material processing, the scheduler/dispatcher could recommend activities that would keep the equipment continuously processing.

4.3.7 Optimize Batch Load Size

Have capability to schedule material deliveries and production activities in such a way as to maximize use of batch equipment capacity.

For example, if a batch equipment has a possible batch size of four lots (100 wafers), the local goal of the scheduler/dispatcher is to have continuous processing of batches in sizes of four lots.

4.3.8 Equipment Dedication

Dedicate specific pieces of equipment to specific operations for a given lot. The dedication may be made at lot start time or after the lot has been processed on a particular piece of equipment.

The dedication may be made at lot start time or after the lot has been processed on a particular piece of equipment. For example, a lot processed on a particular stepper may be required to use the same stepper on subsequent operations.

4.3.9 Selecting Best Equipment for Operation

Schedule activities to maximize yield by preferentially scheduling operations on the best equipment based on previous measurements of equipment performance.

For example, the scheduler/dispatcher could use metrology results to determine which equipment is performing best for a given operation. The scheduler/dispatcher could attempt to prioritize all material at that operation through the best performing equipment.

4.3.10 Minimize Equipment Setup Time

Schedule activities to minimize the need for equipment setup changes.

For example, if four lots are scheduled for a piece of equipment and three of the lots use the same setup, schedule the three with the same setup to run in sequence.

4.3.11 Minimize Reticle Changes

Schedule activities to minimize the need for reticle changes.

For example, schedule lots on equipment that already have the appropriate reticle loaded.

4.3.12 Reticle Availability

Schedule activities to comprehend limitations in the number of available reticles.

The scheduler/dispatcher should not schedule operations on more equipment than the number of available reticles needed for those operations. For example, if there are four pieces of equipment, three available reticles, and five lots to process, schedule the lots on only three equipment.

4.3.13 Cluster Equipment

Comprehend capabilities of cluster equipment.

The cluster equipment type has several kinds of processing chambers. The scheduler/dispatcher should comprehend which chamber is idle at the moment and which chamber is for what kind of processing. For example, while Lot #1 is on processing in *Equipment A* (cluster type), Lot #2 might be able to be loaded to another chamber. Lot #3 might not because it needs same chamber as Lot #1, which is on processing now. In this case, the scheduler/dispatcher should dispatch Lot #2 without waiting for Lot #1 completion.

4.4 Analysis/Reporting Requirements

This section includes requirements for capabilities related to scheduling, that are either predictive (what-if) or analytical (reporting or evaluating) assessments of the scheduling environment.

In addition to real-time scheduling of the shopfloor, the scheduler/dispatcher must also provide the capability for “what-if” offline analysis. This is needed to evaluate the effectiveness of scheduling policies and avoid the negative impact of inserting a flawed policy on the floor. In addition to offline analysis, the ability to evaluate the floor's performance is required.

4.4.1 Predicting Bottlenecks

Predict bottleneck issues that may develop with current policies.

The scheduler/dispatcher, via offline simulation, should gauge the effect of policies on equipment availability and utilization on the floor. An example is the detection of large inventory bubbles created in front of non-constraint equipment due to a particular WIP policy or unforeseen equipment PMs brought on due to excessive loading.

4.4.2 Tradeoff Analysis

Use offline what-if capabilities to assess the trade-offs due to lot/product/process prioritization choices.

As an example, the scheduler/dispatcher must be able to perform what-if analysis to quantify the effect on factory activities of changing product, lot, or process priorities.

4.4.3 Reporting Capability

Produce a historical report of how close the factory came to executing the scheduler dispatcher predicted schedule(s) for the same time period.

Reports should contain data on how close the scheduler/dispatcher met the input goals (e.g., cycle times, product delivery goals). For example, the reports should also be able to identify areas where rescheduling is required to meet factory goals. An example is the case where an equipment (non-constraint) down situation results in depletion of the recommended inventory level at a downstream constraint. The scheduler/dispatcher's performance report in this case may recommend rescheduling the equipment allocation to appropriate product, lot, or process to replenish the constraint inventory as the highest priority, overriding the earlier schedule.

4.4.4 Logging of Manual Overrides

Provide the ability to perform detailed logging of any manual overrides of the scheduler/dispatcher recommendations.

The logging should include such items as when the override was done, the circumstances at the time, information on the person overriding, reason for override, etc. The logs should be available later for analysis.

APPENDIX A
Definitions

Activity	Work performed as part of the manufacturing operations of a factory. Manufacturing activities may be specified formally by a predefined type of Job Specification (for example, Production Job, Transport Job, or PM Job), or they may be represented by partial or informal specifications in the case of manually performed or managed tasks.
Dispatch Decision	Recommendation of the next specified activity to be performed from the perspective of material or one or more of the required factory resources. Reference SEMI E81, Section 7.2.14, for more explanation of dispatching.
Dispatch List	A listing of dispatch decisions in priority sequence.
Dispatching	Generation of a dispatch list decisions whose objective is to optimize factory productivity by recommending the next activity for a resource or material based on rules that interpret the current state of the factory, the priorities and requirements for the activities, and the relationship of the activities to one another.
Factory Planning	The process of recommending lot starts for a particular production facility over an extended period of time. The time window considered in factory planning would be defined by a particular corporation's planning policy. The factory plan is determined by predicting future changes in factory state as lots progress through production. This projection is used to determine the optimum sequence of lots starts to best achieve the production goals of the facility. The outputs of planning system would be start goals.
Job	*Reference E81 5.2.23 job — Some system level operation whose execution may be requested by an entity whose responsibility it is to manage jobs. The job concept is analogous to operations performed on the "factory floor" in a physical factory.*
Job Specification	A detailed statement of some work to be performed (for example, process operation, material transport, or preventive maintenance task), the material upon which the work will be performed (for example, lot or material group), the resources required for that work (for example, production equipment, durables, operators), and constraints such as priority and deadline.
Reference E81, Section 7.3.4.5.1	*"A job implements a specified task on specified material using specific resources."*
Reference E81, Section 7.3.4.6.3	*"Job Specification. – Job description (process flow, recipe, transport destination, aintenance spec, etc.). – Priority and deadline."*

Scheduling	Scheduling makes recommendations of start and stop times for activities in the factory. The granularity of these recommendations may be coarse (for example, prioritizing products at an operation per shift) or fine (for example, sequence of every lot start at a particular operation). The recommendations are based on knowledge of factory-level goals and capacity. The objective of scheduling is to optimize factory productivity by recommending a series of future activities based on business rules.

International SEMATECH Technology Transfer
2706 Montopolis Drive
Austin, TX 78741

http://www.sematech.org
e-mail: info@sematech.org