Real-time Planning & Scheduling at Philips Semiconductors

One of the most difficult environments for planning and scheduling is semiconductor fabrication line. Characterized by long lead-times, interplant dependency, high occurrence of breakdowns and scraps, and notably expensive equipment, fabrication lines and back-end processes present a very challenging job-shop environment for planning and scheduling. In addition, the industry faces highly fluctuating demand changes, variable mix of end-items, and vigorous competition internationally. In this paper, we describe deployment of Adexa™ planning and scheduling system at Philips Semiconductor facilities and describe how Adexa is used, in conjunction with their MES system, in order to make capacity reservations, commit to forecasts, release lots, and form dispatch lists for all equipment.

Planning Process and Order Commitment

Forecasts are received from each product group (customers), as unconstrained demand, on a monthly basis. Each product group is responsible for a number of products and technologies (i.e. family of products). The forecasts, by product, are generated by different product groups. The fabrication lines and sort areas, after examining the capacity and material requirement of the forecast, will make a commitment in terms of number of wafers that can be delivered in future periods. These commitments are made by Technology. The implication is that, although the wafer quantity by product may change, the wafer quantity by technology may not be exceeded. Different products have different capacity requirements. Therefore, by changing the product mix, there is a chance that the capacity requirements may change from what was originally anticipated (based on the forecast).

After a commitment is made to each product group, by Technology or by Product, then the actual sales orders (work orders) will follow. Work orders arrive a number of times each day with a customer requested due date. The requested quantity is checked against committed quantity and a promised shipping date is then generated based on material and capacity availability. Traditionally, this is done based on the number of wafers and/or units (in the back-end processes). However, this is not an adequate approach since units of different wafers or devices do not map into the same capacity requirements leading to erroneous commitments. This issue is particularly important where there is a high mix of end-items. There must be a mechanism for translating capacity and number of wafers.

Before Adexa™ planning & scheduling software was deployed, the promised shipping dates were based on historical fixed lead-times. A measure that is insensitive to the product mix and WIP inventory. In addition, the time taken for collecting the right information in order to respond to the requested order was too long. The shop floor control system would then assign priorities to the lots (manufacturing orders) at each resource and try to push the execution of orders that seem to be more late than others. In the meantime, more WIP was generated based on a pre-defined number of starts per day. The number of starts was based on capacity availability of certain bottleneck resources. As more WIP accumulated, the lead times increased causing more late lots (late orders). Pre-defining bottlenecks in fabrication lines is not a very effective approach because the bottlenecks are shifting based on product mix and availability of equipment.

Strategy

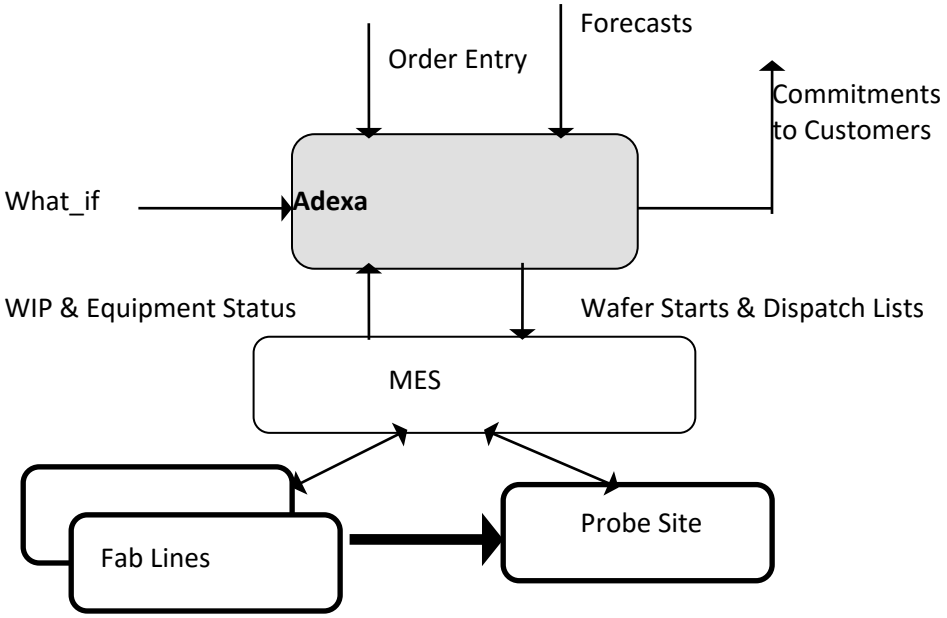
Philips Semiconductors was committed to low cycle times and on-time delivery. A study was initiated in order to understand the major areas of improvement and focus on those activities where 80% gain can be obtained through 20% effort. Smart release of lots into the fabrication lines was considered to be one of the critical issues to be addressed. Smart release implies starting the lots at a point in time so that the wait-time of the lot is minimized and the bottleneck resources are kept as utilized as possible. The key to smart release is to have the ability to look ahead and decide when each lot should be released into the fab lines. The timing of release, if performed properly, will minimize the need for more reactive methods of sequencing and dispatch list generation.

Deployment of Adexa

Most of the needed information is made available to Adexa through the MES system. This includes current WIP, current and expected status of equipment, and routings. Every time that new orders arrive from the customer sites (or Product Groups), they are compared against the quantities that are being made including scraps that may have occurred. Based on the difference between the demand and supply of wafers and inventory positions, the new quantity of wafers that need to be produced is decided. At the same time, the new request is compared against the original commitment to the customer that was made previously. If the new order exceeds the contracted quantity (made at the time of forecast), then business rules may be invoked as to what should be done.

After orders are entered into the Adexa, it performs die-to-wafer conversion and lot sizing. Adexa will then generate a commitment date based on the current capacity & material availability as well as the original contractual agreements. By relating the actual orders coming in on a daily basis, to the original contracts made to the customers, Adexa ensures the consistency of the actual sales orders and the capacity reservations made on a weekly or monthly basis. This feature makes Adexa an ideal real-time Available-to-Promise engine. Adexa's planning logic includes parameters such as availability of capacity, importance of the customer, and raw material (silicon) requirements.

2. System Architecture



Routing data, equipment maintenance, WIP status as well as shop floor model is down-loaded from MES to Adexa. Forecasts and customer orders are entered into Adexa via the corporate order entry system. Other data items include silicon availability and resource calendar.

The frequency of data transfer is a function of how often the data is changed. For example, WIP status is read into Adexa every time that new orders are entered into Adexa. As an extension of integration with MES, the next step is event-driven operation of Adexa, where Adexa would send dispatch lists (via MES) to each equipment, or Work Cell, every time that a MVOU or machine breakdown occurs. Note that if the event was predicted by Adexa, there is no need for a new dispatch list.

Benefits

Introduction of Adexa at Philips Semiconductors has produced a number of unprecedented benefits and results. Through better visibility, Adexa is enforcing the required discipline and it is institutionalizing the on-going process of data correction and practices that are defined by the management. Examples of the latter are on-going cycle time reduction and continuous improvement in delivery performance.

Adexa has also helped to optimize a number of key parameters including cycle times, work-in-process volume and delivery performance. After a few months of Adexa operation, delivery performance, measured by percentage of on-time delivery, was improved by high double digit percentages resulting in close to 100% delivery performance. Cycle times and WIP levels also improved by comparable amounts.

Equally important to reducing the manufacturing cycle times was the reduction of planning cycle time. The latter is a critical tool for being more responsive to the customers. Adexa has helped to reduce the time from forecasts to commitment from weeks to hours. Furthermore, the time needed for promising a delivery for each work order can now be performed while the customer is waiting on the telephone. Other intangible benefits include real-time status checking of orders, what-if analysis for business and

ramp up purposes, and the ability to perform the planning functions from forecasting and commitment to release of lots and machine sequencing all in ONE environment, viz. Adexa. Such an integrated environment has helped Philips to avoid the use of individual spreadsheets, hard-to-maintain simulation systems and many other home-made systems which have constituted the traditional planning functions in semiconductor and other industries.
