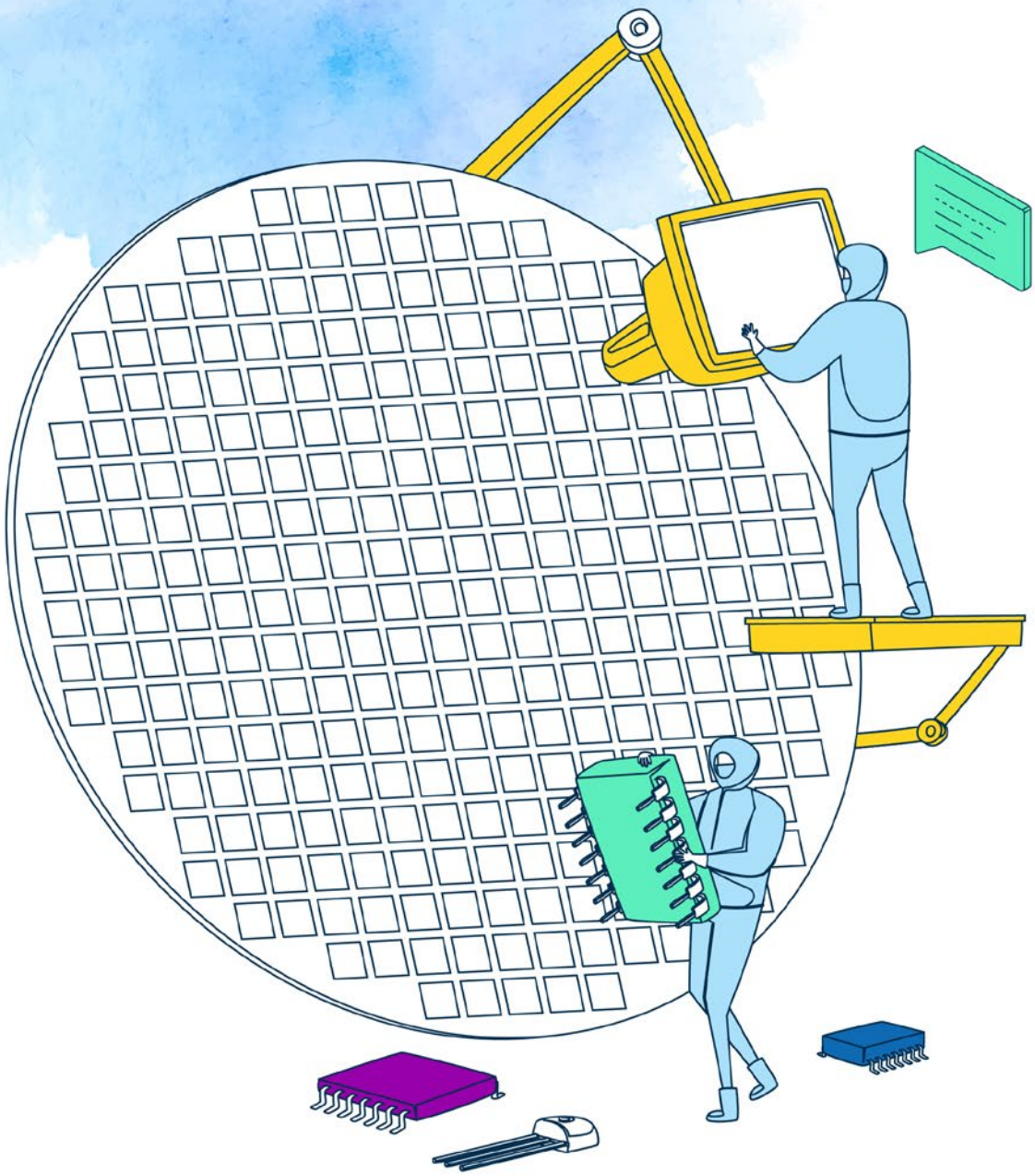
ADEXA Predict, not just response

Stop Planning Semiconductor Chips Like Potato Chips!



It's no surprise that the Semiconductor industry is very asset-intensive, with long leadtimes and expensive capital equipment. Your supply chains may span the world and include assets that are owned by you, or other outsourced manufacturers.

This expensive capital equipment must be highly utilized in order to meet ROI goals, or just positive gross margins. With typical product lifecycles of less than 6 months, and sourcing lead-times of 3 to 4 months, it is imperative to make production decisions for new products even before the market demand is clear.

Add to this the difficulty of managing multifaceted product specifications for every customer, and you end up with a complex planning challenge which requires special planning functionality, that goes beyond the typical logic in most planning systems. In spite of this, many Chipmakers deploy "me-too" planning systems designed for industries that have similar requirements to Consumer Packaged Goods companies, like for potato chips.

Trying to meet semi-planning requirements with a system designed for general inventory planning is not a good way to meet your tough planning needs. In this ePaper, we first explore how the use of product *attributes* can simplify your planning environment.

Then we review the major differentiating requirements for the top Semi-planning processes, including Demand, Inventory, Operations, Supply, and Available-to-Promise planning stages.

Why Product Attributes?

Attribute-based planning capability is a must for the Semiconductor industry. A typical customer specification in the Semiconductor industry will require around 7 *attributes* with an average of 10 choices for each attribute to fully describe the product to customers (Examples are: memory size, alternate components, speed designation, place of manufacture (Fab, Assembly), package type, date-of-manufacture, engineering revision, lead frames, package type, and power). If traditional or Smart Part#'s are used for master data management, then hundreds-of-thousands, or millions, of Part#'s would be proliferated with no way to apply business logic around them.

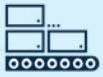
The cost on data maintenance, planning software complexity, and hardware required is enormous. The only reason a company would be forced into doing this is because they are using a system that was designed for the CPG industry, and not Semiconductor-specific requirements.

Instead a company can deploy a system with attribute-based planning and manage with just 7 to 10 *attributes*, used with a common-base Part#. The exact *attributes* required by a customer are attached with a customer specification, or with each order. Impact on the plan is handled by the attribute-based logic. Next page will present examples on how it's used in Semiconductors.

Note: For more information about this important topic go to our comprehensive **Attribute-Based Planning**

Semiconductor supply chain and frontend/backend planning are one of the most complex requiring a precise digital twin to enable optimal use of equipment and lowest cycle times.

Attributes in action



Product range and grades

Attributes can be associated to one or multiple "lots" of generic products, with either a range, or grades, at any point in the manufacturing process. This functionality is used by organizations to match supply and demand according to specific customer requirements. In this way, it is easy to see if a production-lot will meet a customer's specifications. Systems made for CPG environments cannot do that.

Qualification matrix

The Qualification Matrix is used to define product revisions and subcontractor locations that have been qualified or accepted by each customer. As demands are placed into the model, the planning tool will only peg to the accepted product and location defined in the Qualification Matrix, for each customer. This is also applicable to process variances within a manufacturing stage per customer--if Customer "A" requires that system level test be conducted before shipment and Customer "B" does not, then attribute associated with this criterion will match and inventory will be planed, accordingly.

Date code range

The Date Code Range is the acceptable date-of-manufacturing limits that customers can put on an order. *Attributes* are the only way that a company can handle this requirement, since the Date Code Range will change with each order. Traditional planning systems cannot handle this, and therefore cannot tell when a customer order can be satisfied.

Demand Planning

When it comes to discussing major planning processes for the Semiconductor industry, it makes most sense to start with the customer.

Most planning systems have been designed for conventional industries, where product lifecycles are long, and it's much easier to link demand history of older products to new products. Semiconductors' ultra-short product lifecycles present a big challenge to the traditional demand planning solutions.

These systems rely heavily on statistical trends, which predict less accurate forecasts as new products are introduced to the market, in shorter timeframes. Also for more conventional verticals, there are fewer technical specifications or *attributes* to classify, or subdivide, the same set of products for analysis.

In the Semiconductor industry *attributes* need to be used for both sales trend analysis, and to help predict new product demand.

Here are some of the capabilities for an ideal Semi-based Demand Planning system:

- Utilizes *attributes* to segment the product lines based on key-characteristics
- Ability to have multiple parallel hierarchies for segmenting products for analysis
- Ability to calculate expected revenue by using average-sales-price (ASP) based on "views" of data for the various *attributes*
- Ability to visualize the impact of constraints from upstream stages (i.e. Fabrication Lines)

These are just the unique factors that would be required for Semiconductors. A more complete list would also contain statistical forecasting, collaboration, workflow, etc.

Multi-Echelon Inventory Optimization Planning

Inventory Planning in a Semi-company needs to be coordinated across the entire supply chain at many levels, which includes subcontractors and in-house manufacturing. A typical system would only look at the end-item inventory buffers.

Multi-Echelon Inventory Optimization will consider how much inventory needs to be held at each stage of the supply chain (Die bank, tested product, packaged product, customer hubs).

Most critical is to determine how much of a buffer to hold, in the Die bank, to protect against uncertain demand on the Fabrication Lines.

An ideal Multi-Echelon Inventory System for the Semiconductor industry would be able to do the following:

- Balance the cost of a stock-out against the cost-of carrying inventory. (Inventory carry-cost should include the risk of obsolescence, so that the system optimizes the tradeoff between stock-out-cost and inventory cost)
- Set the basic inventory levels at both the end-item (i.e. after test) for make-to-stock products, and at the Die bank—with consideration for lead-times through Assembly & Test
- Allow the user to dictate service-levels for the Die bank so that the Die bank objectives can be achieved through enforcing the policy

Note: For more information about this topic go to **Multi Echelon Inventory Optimization**

Operations Planning

The Operations Planning is part of the overall S&OP planning process. It needs to determine what forecasts to satisfy if constrained, what inventory levels to target, the build plan for Fab into Die bank, and the amount of subcontractor capacity in Assembly. The needed input is the Demand Plan and the Inventory Plan, as already discussed. At this stage, “What-if” analysis capability, to compare various planning scenarios, becomes essential.

The differences for the Semiconductor environment need to be addressed in the Operations Planning system by considering the following circumstances:

- The unpredictability should be considered at the Fab-level more than the end-item level. This is because products can be manufactured to the Die bank and then completed later (i.e. uncertainty around Die bank demand needs to be addressed)
- The impact of Qualification Matrix needs to be considered. If specific customers represent a disproportionate amount of the forecast for a given product, it may skew the capacity requirements for certain vendors. This in turn could throw off required inventory builds. *Attributes*, or specially named SKU’s, need to be used to keep this visible
- The long manufacturing lead-times of chips are also very different than in traditional industries. This is especially difficult for “time-bucketed” systems to handle. The system has to be able to manage cumulative lead-time across buckets
- The ability to address and analyze special requirements of any kind for specific customer needs. This includes special packaging, materials, or other restrictions that need to be considered in the S&OP time-horizon

If many of the above are factors in your enterprise, it may be necessary to perform longer range planning on a demand-by-demand basis using Master Production Planning tools. The easiest question to ask is: “how much do customer specifications affect the 12-months plan?”

Supply Chain Planning

Supply Chain Planning is where the rubber-hits-the-road for the Semiconductor industry. When business is good there will be a capacity bottleneck in Fab, limiting the supply of wafer-starts available to satisfy customer orders.

This bottleneck is two steps away from the finished-goods stage and must be managed carefully. The planning algorithms of traditional systems (which net inventory at each level of the Bill-of-Materials) makes it impossible to determine how critical each dependent-demand really is. These systems cannot tell if new starts are required to just fill safety-stock, or to meet a hot customer order.

An attribute-based planning system can propagate the specifications of the customer order, at each stage of planning. The order based approach of a system built for the Semiconductor industry is very different than one built for the CPG logic—where the focus is on planning generic inventories, and not orders.

Also, with order-based approach with *attributes*, each order is planned and coordinated by stage—ensuring the most important orders are handled with the highest priority.

The following capabilities are specific to supply chain planning systems built for the semi-based enterprises:

- The semi industry has alternative BOM's and complex routings that have 100 or more operations. It also has processing times that change based on resource combinations used (i.e. tester-handler combinations). Accurate order-commit dates and capacity usage calculations requires software that can handle this in a concrete manner
- Ability to propagate the priority of the order line-item, so that the WIP and work-orders in the Assembly & Test areas can be planned based on importance. Remember, planning systems built for the CPG industry drop visibility to order priority when finished-goods inventory is netted
- Ability to handle *attributes* that describe the site-qualifications of the order. Inventory based systems lose visibility to the order, and therefore cannot plan into the correct manufacturing location
- *Attributes* should handle the grading, and other engineering characteristic, of the inventory after probe. Again, this capability is none-existent in inventory based planning systems built for the CPG vertical
- The planning solution must recognize all other product specifications, which make each customer order unique. An example is an acceptable manufacturing Date Code Range. Only an attribute-based system can handle this, and therefore only such a system can give accurate plans

Available-to-promise & capable-to-promise

Supply Chain Planning and real-time Available-to-Promise (ATP) solutions have similar requirements when it comes to the Semiconductor industry. The big difference is that all the special planning logic that has to be applied to the Semiconductor industry needs to be done in less than a second.

That is the only acceptable amount of time after the customer service representative presses the button to check on availability-date quote for a potential order.

Accordingly, all the priority-logic, allocation, date codes, qualified contractors, Die revisions, capacity in assembly, and available wafer-starts must be applied within that very same second.

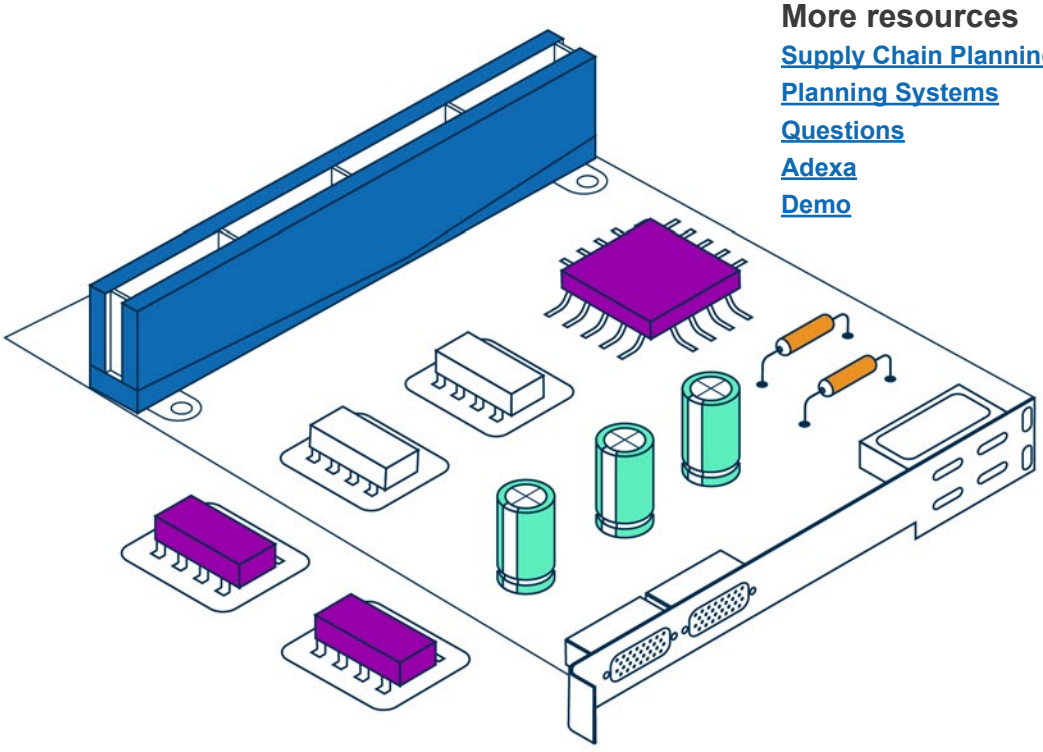
It takes a system with special capabilities to handle this. If given less than a second, at best the traditional planning systems can only net from committed forecasts and finished-goods inventory.

Another key difference is the Capable-to-Promise (CTP) logic required. CTP is a critical function used for promising orders when inventory is not available. It has to consider capacities, priorities, availabilities, etc.

The long lead-times for Chips and the complexity of planning for Fabs, Assembly, Test, and Packaging make the Capable-to-Promise calculation tricky—to put it lightly.

In order to have a solid ATP/CTP process and system for the Semiconductor industry, keep the following in mind:

- The system must be able to create new work-orders at any level of the supply chain. This must consider WIP at each stage, and the constraints in Fabs and Assembly & Test areas
- *Attributes* are important in defining the specific product that is desired by the customer. To that end, the ATP system must be able to describe demand and supply factors, and their associated business rules, by use of *attributes*. A good example is Manufacturing Date Codes, or any other customer specifications. This would eliminate explosion of end-item Part#'s (coming from supposedly "Smart" Part#'s)
- The system should be able to determine when finished-goods must be saved for high priority customers. This requires the capability to check WIP levels and available start capacity, to minimize resulting supply issues for lower priority orders



Conclusion

Any Semiconductor company looking for supply chain planning solutions should not have the expectation that systems targeted for use in the general industries, like CPG and Retail verticals, would be able to handle their environment.

Capabilities like attribute-based planning, order-by-order planning, and the ability to propagate order priority and customer specifications back through all stages of the planning processes can only exist in systems that are built for the Semiconductor industry.

If these capabilities are missing, customer service will be compromised, and inventory levels must be increased to protect against what other systems cannot see, or calculate.

In fact, it's the other industries that should implement and imitate the planning solutions used by the Semiconductor companies—indeed one of the most complex supply chains to plan, and very different from planning for a sack of potatoes.

More resources

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Adexa 5777 Century Blvd. Los Angeles, CA 90045 USA (310) 642-2100 | (833) ADEXAINC www.adexa.com info@adexa.com
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