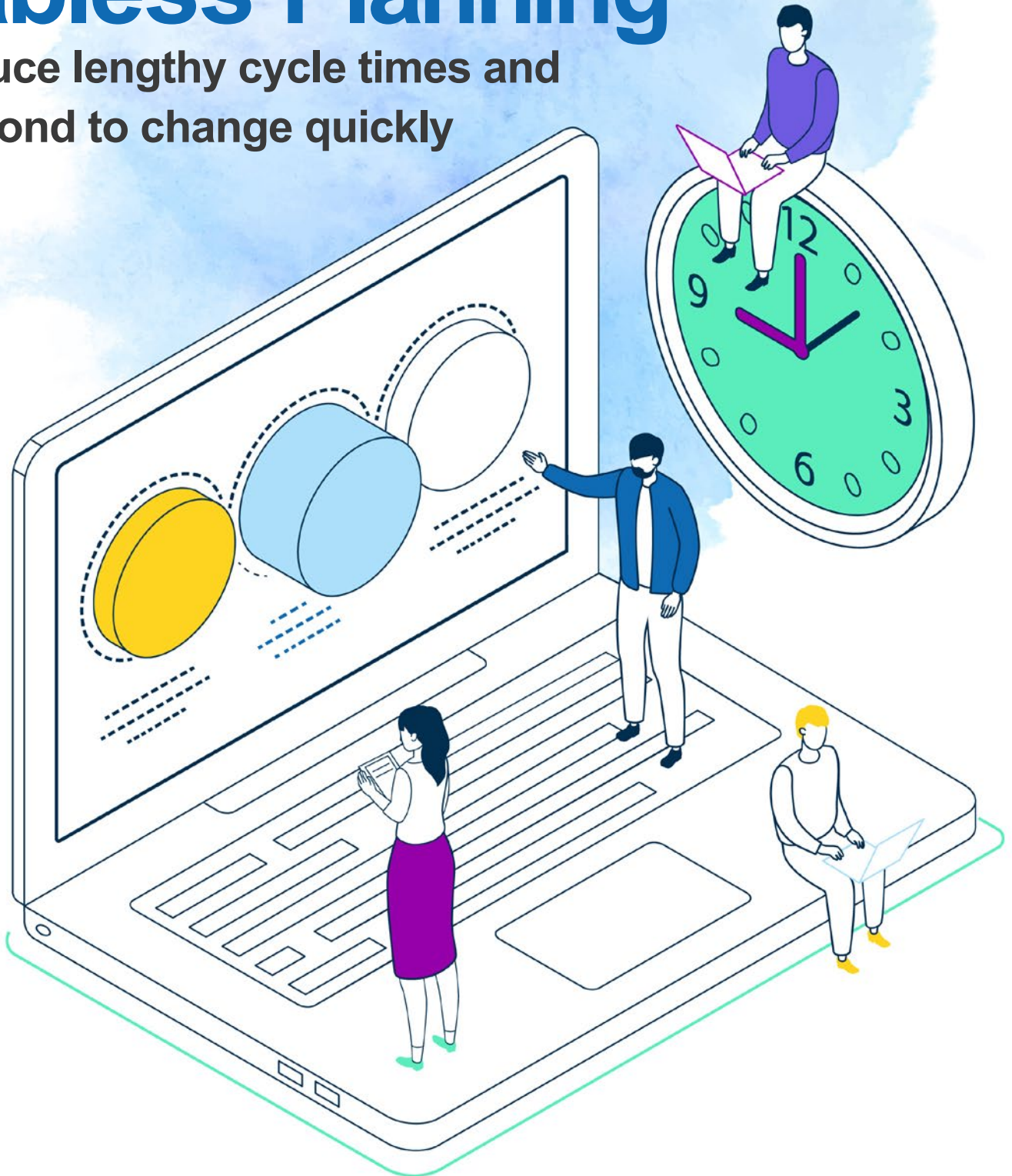




Achieving World-class Fabless Planning

Reduce lengthy cycle times and respond to change quickly





The Fabless Semiconductor industry achieves high growth rates and superior return on assets by outsourcing practically all of its manufacturing needs. While not having in house manufacturing frees a company from the burden and expense of having to invest in expensive capital equipment, it brings a new set of challenges in managing the supply chain.

The fabless semiconductor supply chain consists of wafer fabrication sites (foundries), probe, assembly, and test houses that are owned by different external companies.

This arrangement poses a unique challenge in that it is necessary to manage inventory and a customer order across multiple organizations in order to reduce lengthy cycle times and respond to changes quickly.

Complicating the situation is the increased complexity that the Fabless companies are building into their products in order to resist commoditization and offer higher margin products to their customers. Illustrated below is the general relationship between fabless supply chain, subcontractors and customers.

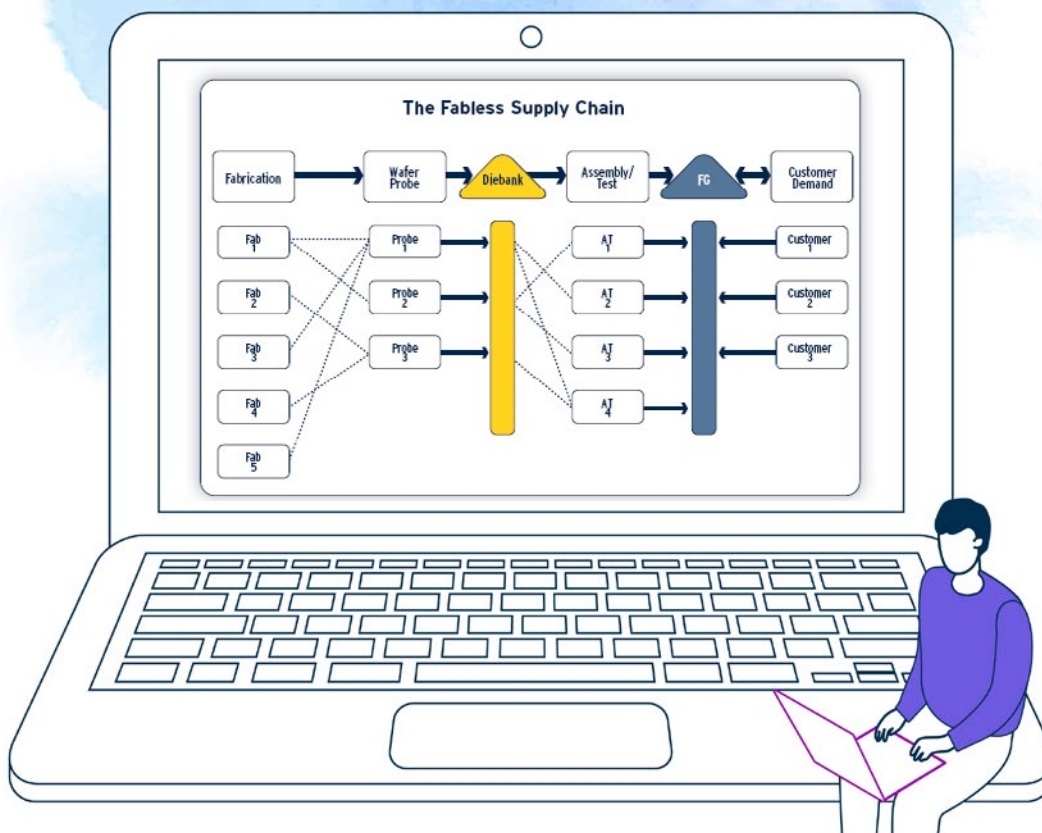
Planning in this kind of environment can be complex and inefficiencies are common because many of the Fabless companies use predominantly manual processes, or spreadsheets integrated to their transactional ERP system that were economical when they were small.

The question that organizations encounter is how to improve their supply chain management capabilities in a way that adds value to their business.

Fabless companies have a basic IT infrastructure in place and are looking to add the capabilities of supply chain planning tools to help them increase profitability.

The primary reasons cited by the fabless companies for looking to purchase a supply chain planning system is to plan a more profitable product mix, reduce inventory, improve customer service rates, reduce slow moving products and obsolete inventory costs, provide supplier visibility, and increase the productivity of the planning group.

Many fabless companies have found that supply chain planning systems offer a great value proposition in these areas. This paper explores the planning needs of the fabless industry and describes how fabless companies can improve their business through superior supply chain planning.





Supply Chain challenges for fables

The barriers for a fables company to increase revenue, increase customer service, decrease inventory, and lower the direct cost of operations are different from a company that manufactures its own product. Putting in place world class supply chain management processes and systems can have a substantial impact on each of these areas.

Surveys of Fables companies have found that many of them can realize these benefits if they improve their supply chain management capabilities to overcome the following challenges.

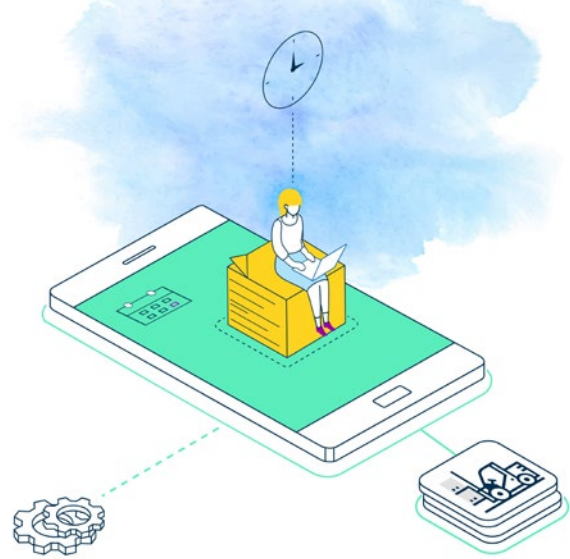
Fables companies need to keep offering more and more specialized products to avoid commoditization in the market place. Many companies started with a new product technology offered to a niche market. As the larger integrated device manufacturers start to impinge on their unique product offering, the fables companies need to keep margins high by offering specialized characteristics (attributes) to each customer.

This explosion of product variety can make the supply chain very complex to manage. If a fables company can put in place an effective strategy to manage product variety and keep the cost of operations from increasing proportionately with the number of products offered, it would be more profitable. Best in class companies are adopting attribute based product management to meet this challenge.

A key performance indicator for all companies is on-time delivery of orders. There are multiple factors which affect on-time delivery performance that fables companies need to address. One is increasing the accuracy of the demand plan.

The long cycle through the Fabs makes it necessary to rely on forecasts so that the die bank has the right inventory on hand. If this is done correctly the fables company is in a better position to react when the order is placed. The typical fables company uses spreadsheets, or a data warehouse to accumulate demand plans.

This makes it difficult to collect all the sources of information and communicate them to various stakeholders in a timely manner. A best-in-class company has an integrated Sales



Fables companies need to have the capability to have real time visibility and continuous planning to give precise delivery dates to their customers.

and Operation planning system in place with its suppliers so that a major planning cycle can be completed on a monthly basis and small changes done daily as required.

A second critical capability for achieving higher customer service is the ability to accurately plan supply through the various stages of the manufacturing process considering material availability, purchase order status, and capacity. Most companies use a combination of ERP systems and spreadsheets for calculations as to how much of each product can be manufactured in each time period.

Once calculated, the requested schedules need to be communicated to the suppliers. In order to close the loop, suppliers need to return a commitment on what they can supply.

This collaboration is typically done with e-mail and spreadsheets, making it slow and ineffective. In order to understand if there will be a problem delivering orders on time, the Fables companies need to have visibility into the status of the work orders released to the Fabrication and Assembly Test facilities.

The planners should only react if the supply order will be late and the impact on the customer orders is significant.



A best-in-class company will use a material and capacity constrained planning system that can coordinate the flow of materials across the entire supply chain.

These systems need to be combined with a supply chain visibility system that enables planners and expeditors to know the current status of WIP at the supplier and highlight if something is off schedule.

The outs schedule from the Fabs should be done on a weekly basis and Assembly test schedules should be done daily or even more frequently as orders are received especially for make to order businesses.

To implement a best-in-class process, two or more planning cycles a day should be run enabling orders taken during the day in North America to be processed in Asia while N.A. sleeps and vice versa.

A company that only runs one batch planning process during the N.A. night time, will miss one day of order cycle time in Asia, therefore needing an extra day of inventory and order delivery cycle time. Best-in-class companies also obtain frequent updates from suppliers on the status of open orders.

Another consideration around customer service is how quickly the customer service representative needs to quote the expected delivery date. If a real time quote on expected delivery date is required that is accurate and considers the real-world constraints of the supply chain such as supply allocation, capacity, and material availability, then specialized systems and processes are needed.

The customer service representative will need to be able to consider what inventory is available, what inventory will be available in the future, and has the current or expected inventory been allocated to another customer.

For available-to-promise (ATP), most companies currently use a first come first serve quoting scheme in their ERP system based on some unrealistic pre-defined fixed delivery times.

Fabless companies can control the amount of inventory in their supply chain by attacking two key core competencies.

The accuracy of the demand plan will have a big impact in this area since increases in forecast error will increase the amount of inventory required to cover for surprise orders.

A fabless company would be able to decrease inventory if they had a better way to measure error in expected demand, and use this information to help decide how much inventory to deploy at each stage of the supply chain. The typical company uses the planner's best guess in days of cover for various inventory points in the supply chain.

A fabless company or any other company that uses outsourced manufacturing can also put in place planning processes and systems to reduce the cost of purchased materials and capacity. Manufacturers that outsource typically have more than one sourcing alternative for manufacturing products.

Some customers may require that the product be made in a particular fabrication facility or tested in a specific test house, while other customers will allow alternatives. The fabless company must manage the current order book and the load that it puts on the vendors.

By considering both orders and forecasted demands against available WIP inventory in the supply chain, customer preferences for sourcing, available capacity from subcontractors, cost of materials, and purchased capacity, a fabless semi company can reduce obsolete inventory.

Many companies try to use spreadsheets and MRP systems to handle this task. World-class companies use planning systems with the capability to perform offline planning scenarios in order to come up with the best plan.

Achieving a world-class planning environment

Putting in place world class supply chain planning processes and systems will allow a Fabless company to increase its top-line sales numbers and increase margins with reductions in inventory, and costs of operations.

The business processes that are critical to address are Sales and Operations Planning, Demand Planning, Operations Planning, Inventory Planning, Master Production Scheduling, and real time Available to Promise.



Those companies that want to be able to increase profits by offering more variety in their product line and a more tailored customer experience should consider a move toward *attribute based planning*.

The following sections talk about how Fabless companies can benefit from attribute based planning, and can get to world-class status in each of the supply chain business processes mentioned above.

Attribute based planning

Attributes have traditionally been used as a way to manage the supply chains of companies that sell products that have complex engineering specifications.

Examples of these are electrical properties on high tech components, ranges, grades, and qualifications. Fabless companies are realizing that Attribute Based Product Management should be applied to the products they sell.

This enables them to charge premium pricing for products that were previously threatened by commoditization, but are now engineered with specific qualities for individual customers.

In addition to engineering specifications, fabless companies are using attributes for grading inventory and qualification of manufacturing locations.

Product ranges 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 and account for their fluctuations in production efficiencies.

Qualification matrix

The Qualification Matrix is used to define product revisions and subcon 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 processes 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 association will match and inventory will be planned, accordingly.

Sales and Operations Planning

Demand Planning

As a Fabless company grows, it becomes more critical for it to be able to develop and update a dynamic consensus Demand Plan that takes into account the views of the many groups responsible for shaping demand.

This includes the sales people that are talking with the customers, the demand planners responsible for passing the demand statement to the operations team, marketing for long range demand plans and new product introductions, and even the customers themselves.

A world-class demand planning process is characterized by the following capabilities:

- An environment that provides the capability for all participants to enter, view, modify and analyze data in a secure environment so that a consensus view of demand can be decided
- The system should provide the ability to manage the business process using workflow and exception management
- The ability to calculate statistical forecasts for lower value products
- The ability to visualize constrained supply data from the operations group with the demand plan to be able to see how much of the forecast can be delivered
- The ability to calculate expected revenue using average sales price
- Utilizing attributes to segment the product line based on key characteristics

The following product snapshot, from Adexa's Collaborative Demand Planner, shows all the essential elements of a consensus demand plan. It contains input from the various stakeholders and a methodology to manipulate the various sources of input into a consensus plan.



Inventory Planning

Inventory Planning in a Fabless company needs to be coordinated across a virtual supply chain. Depending on the needs of each company there are varying degrees of complexity that a company can use for planning inventory. The strategy for inventory planning should also include a core set of key performance indicators (KPI's).

Best in class companies have the following characteristics for inventory planning:

- Key performance indicators are set up for both Demand variability and supply variability and measured on a regular basis. The data that is used to measure performance is coordinated with lead times for procuring products and materials
- Basic inventory levels are set at both the end item after test for make to stock products and at the die bank with consideration for lead times through assembly and test
- Measures of variability in the KPI's use aggregation to pool for commonality in sub-components in the die bank
- Consideration is given to the ability to move product between locations when considering finished part inventories

Operations Planning

Operations Planning in the Fabless environment should be part of a closed loop Sales and Operations Planning (S&OP) process. It should coordinate the demand plan with the

operations plan, and provide financial metrics for meeting the demand plan.

When combined with the demand plan, it should provide confirmation whether the company is on track to meet the yearly financial goals. The Operations planning process should have the following capabilities:

- Ability to consider multiple alternatives for supply considering constraints for materials and capacity as required
- Utilize incremental costs to consider financial impact of the supply alternatives. Be able to cost out the incremental unit of supply based on constrained alternatives
- Be able to consider the revenue of products in order to be able to maximize profit when deciding which demands to meet if supply is constrained
- Have the ability to collaborate with suppliers to communicate required units and capacity to meet the supply plan. Be able to take a reply from a vendor and run what if scenarios to see the impact of the demand plan

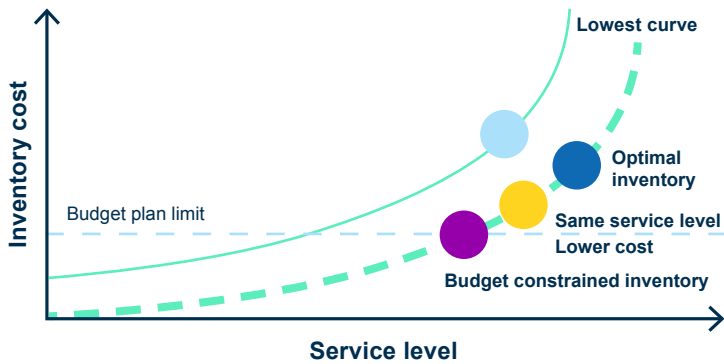
The combination of Demand Planning, Inventory Planning, and Operations Planning in a single environment enables a Fabless company to put in place a world class Sales and Operations Planning process. The following product snapshot shows how the S&OP plan brings together the entire supply chain with a view of the financial impact.

Order Planning

The combination of Master Production Scheduling and Available to Promise provides a company with the ability to ensure that orders are quoted in a timely manner and delivered on time. Success in this area increases customer satisfaction and has a direct impact on sales and cost of goods sold.

Master production scheduling

For the Fabless company Master Production scheduling has two major processes. The first process, which typically runs on a weekly basis, serves to establish the starts and outs required for the wafer fabs. It also sets a forecast of expected product volume for the Assembly and Test facilities.



The second process, which runs daily, serves to match WIP and Inventory with the incoming orders to plan inventory moving through the Assembly and Test houses. A world-class capability needs to be able to handle the following requirements:

- The system needs to be able to handle attributes that describe the order. The attributes need to be able to handle the grading of inventory after probe, and other engineering characteristics of the product
- The system needs to ensure that inventory that is on hand or in process gets used up by the current order book as much as possible so that slow moving inventory and obsolete inventory is kept to a minimum
- The planning solution must be able to recognize which products need to be produced at specific locations to meet specific customer requirements. This qualification matrix needs to be time phased and be able to show preferences

Available to promise

The master production planning process allows a company to quote due dates to customers based on the Master Production Schedule which is run periodically. If a company wants more control over when it will promise its limited inventory, a real-time Available-to-Promise environment is required—with appropriate supporting technology.

It should be used when a first-come-first-serve policy for promising inventory is not sufficient, or if limited product has been allocated to customers. A solid Available-to-Promise process and system should be able to handle the following.

- The ATP process needs to be able to work on a real-time basis so that customer service representatives can give answers while on the phone with customers
- It should be able to enforce a multi-dimensional segregation of available product, being able to follow an allocation that is split by time, customer groups, customer tiers, product family, or any other attribute that is important to company sales
- Attributes are important in defining the specific product that is desired by the customer. In order to eliminate combinatorial explosive end item part numbers, the ATP system needs to be able to handle attributes to describe demands, supplies and the rules to determine if a supply can meet a customer demand
- If sufficient supply is unavailable, the ATP functionality needs to be able to perform a Capable-to-Promise function (CTP) and determine if resource and material availability will support production of the required supply

Conclusions

Fabless semiconductor companies can achieve higher revenues, lower inventory, and lower operating costs by putting in place best-in-class supply chain planning processes.

This in turn has a direct impact on the financial performance of the company in terms of profitability, margins and return on assets. The unique requirements of the fabless industry results from the need to coordinate across many outsourced manufacturing companies.

The common characteristics that cut across all of these processes are the combination of planning intelligence, collaboration, and analytics that will allow fabless companies to achieve world-class status.