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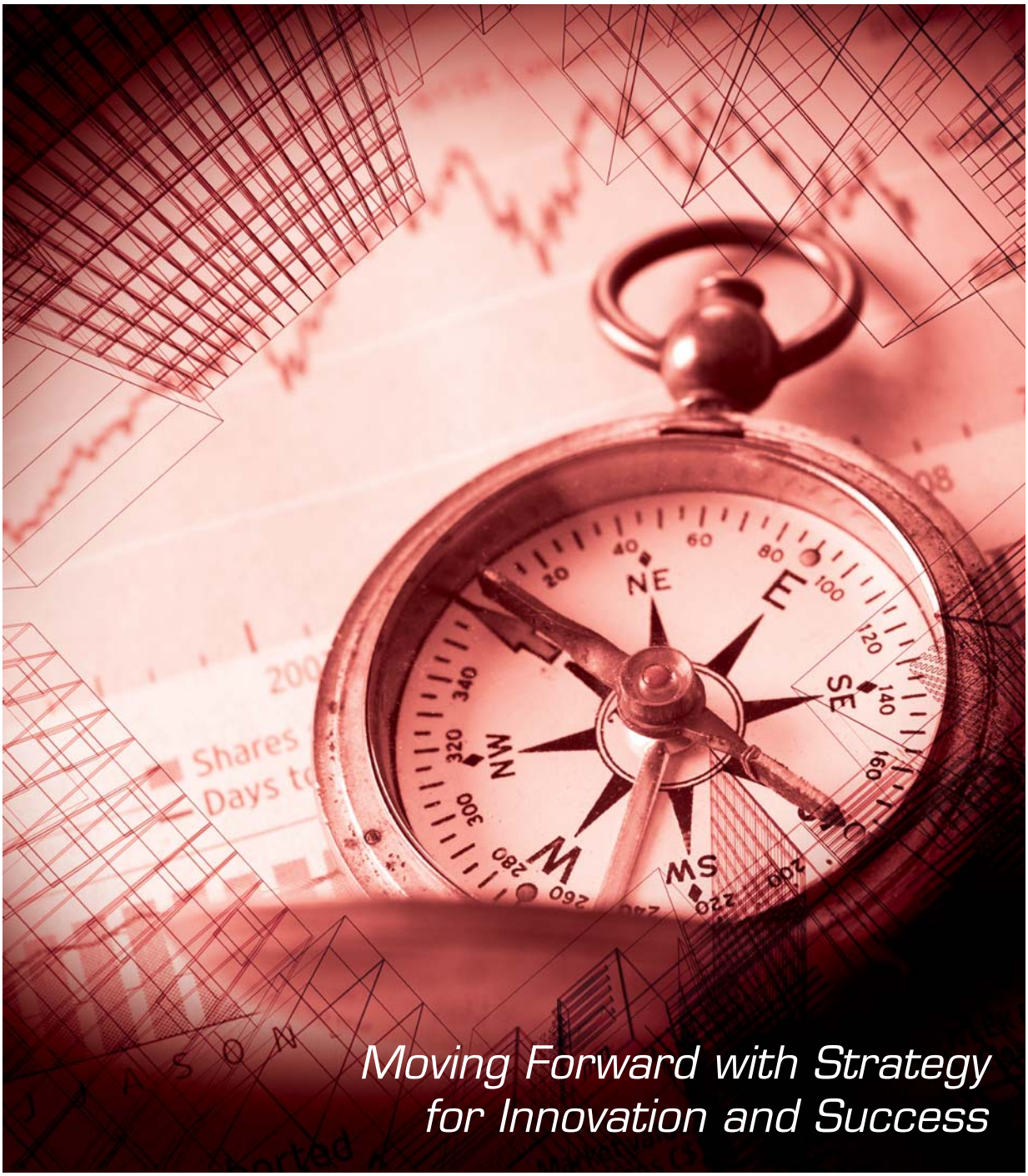

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Semiconductor Cost Reduction Strategies

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A semiconductor operations executive recently shared that his company challenged him to reduce the company's average product cost by a penny a week, a seemingly modest and attainable goal. For the typical semiconductor company, however, this goal is at the core of business success. Sustained achievement of this goal brings the better part of a dollar to the bottom line for each unit delivered, and over the millions of units typical to a semiconductor operation, it harvests measureable and significant profit. Additionally, reducing product cost directly improves gross margin, the primary indicator of semiconductor value creation and a core metric of management effectiveness for the entire executive team.

Operations executives, admittedly, have a full slate of objectives, from supply chain planning and execution to intense focus on improvements to product quality. This, however, does not allow the operations executive to leave the understanding and management of product cost to another part of the organization. Working closely with the financial support teams, the responsibility for both product cost and cost of inventory remains squarely with the operations team.

This article focuses on product cost and cost reduction from an operations and finance perspective. It discusses semiconductor costing by breaking down the components of actual costs and provides a summary of the cost drivers for overall inventory value. Finally, the article proposes a structural model to build sustained cost reduction strategies for the entire semiconductor organization.

Semiconductor Costing

To start, it is helpful to understand how semiconductor product cost is typically modeled through the production process. Most often, product is valued using a yielded standard cost model. At each stage of production, this model takes the product value for the input to the stage, adds the cost of product and/or service at that stage and divides the sum by a planned (standard) yield for that stage. For example, if a chip is going through the "packaged test" step, the product's value going into test might be $4.50, the testing itself might cost $0.50 and the expected yield might be 80 percent. In this example, the yielded standard cost model values the product coming out of that stage at $6.00. Applying this model over the entire production pipeline has proven to be an effective way to anticipate the total cost of production of good product delivered to the customer.

It is worth pointing out that the standard cost model is an active approach to managing cost. In creating the model, the cost and yield goals for each step of production are established and the ongoing results against these goals are measured. The model is not only used to value a product; more importantly, it helps a company to understand the drivers of product and inventory cost and to manage these cost drivers.

In reality, actual costs will be different from the model, and these differences between standard cost and actual cost are captured as variances. Each category of variance tells a story about product cost and presents an opportunity for active management to improve. Variances often exist for:

- Procurement: differences in the actual cost from the supplier and the planned cost.
- Yield: differences based on the variance between actual and standard yield.
- Rework: costs associated with re-testing, re-marking, re-programming and re-packaging.
- Work flow: differences between the planned and actual production flow.
- Absorption: differences in the applied overhead (or equipment cost).

Elements of Cost and Cost Variance

Using this standard model as a lens, a company can examine the individual elements of cost more closely. Successful cost reduction starts by fully understanding these individual elements. Later in this article, who controls these elements of cost will be discussed.

Procurement cost in the fabless model is the fee for the supplier's product or service. This cost includes lot charges of all kinds and any other cost adders (e.g., gold). Standard cost for procurement is usually based on the supplier used (or blended if there is multi-vendor sourcing) and an expected standard lot sizing. Procurement execution decisions by the company often have a larger impact on cost than the supplier fees due to choices such as less than optimal lot sizing or the use of hot lots.

Two types of variances can be tracked for procurement cost—purchase order variance and invoice variance. Purchase order variance identifies purchasing decisions that are different than the production standards and is typically due to explicit decisions made by the company and not the supplier. Invoice variance identifies differences between the purchase order and the supplier invoice and is typically indicative of an issue that needs to be managed at the supplier.

Yield impacts cost in a significant manner. Small improvements in yield over time have dramatic effects on inventory valuation. The planned "standard" for yield at any step is set based on the best estimate for a period of time (usually quarterly or longer). Variances between the standard yield and the actual yield indicate your company's ability to maintain and improve yield goals. When yields are below expectation, it becomes a primary indicator for production problems at suppliers' sites.

Work flow is the basic logistics path planned for the production of the product. This includes supplier selection, plant location as well as shipping and logistics support. Variances in work flow may have significant effect on both production time and cost. While the "standard" for production cost may model the use and logistic support for a low-cost, remote supplier, a supply crisis will quickly

have the organization decide to "hot lot" a local supplier. Interestingly, logistics and work flow costs are often hidden; companies routinely do not add this cost to their products, choosing to move the cost of in-production shipping directly to cost of sales. Depending on the value of the product and the various stages of production, logistics can be a significant or immaterial expense.

Rework is the cost to re-do a great variety of production steps. Sometimes it is required due to doubts about the quality of a lot. Many times it is required to change the product to meet alternative demand. Re-marking, re-programming and re-packing are all examples of this cost. The cost of doing rework occasionally reclaims previously written-off inventory—but most of the time the cost of rework does not add value to the resulting inventory. Rework variance is the difference between the input cost and the output value. The input cost includes the cost of the product coming in plus the cost of the rework process.

Finally, there are the absorption cost categories—the allocation of overhead to production or the allocation of company-owned equipment stored at the suppliers. Absorption cost categories are managed both on the cost input side (the cost of operation) and on the throughput side. (Absorption is based on the estimated cost allocation per unit of production.) Absorption cost variances indicate different production volumes from those anticipated, or differences in the input cost spent.

While the standard model and the categories of variance discussed capture the bulk of product and inventory cost issues, there are other categories of product cost to acknowledge. Royalties are outside the control of operations, but are worth mentioning since they can be significant. Other product costs relate to holding inventory and managing the on-hand quantity. These costs relate to the amount of inventory produced relative to demand—and include costs for warranty, storage and obsolescence.

Inside and Outside Cost

While there are many ways to classify product cost and product cost variances, the key elements of cost have been summarized. At this point, it is useful to differentiate between outside and inside costs. Outside costs result from the interaction with a third party, commonly a subcontractor, and are more often under the control of operations. Inside costs are costs resulting from internal decisions and processes of the company. These decisions and processes are set by a combination of finance and operations. The most common cost components are classified in Figure 1.

Figure 1. Classifying Product Cost

Managing Inventory Cost

Let's first look at the outside costs. The largest and best understood component of product cost is the procurement standard cost. This cost is usually determined based on estimated negotiated rates with subcontractors, and is traditionally an operations responsibility. A solid financial team can add value to setting this cost through use of other variances: to verify the accuracy of the cost, to anticipate potential deviations and to test the internal procedures used in establishing the standard cost.

The procurement standard cost can change for a variety of reasons, including changes by the supplier. Subcontractors set prices for services either at the time the purchase order is placed or at the time the service is performed or product delivered. This timing can have a large impact on product cost and can generate large unexpected variances. To allow a more predictable and stable standard cost, operations should negotiate with the subcontractor to have the price set at the time the services are performed, as this method eliminates the uncertainty related to unknown delivery dates.

Cooperation between operations and finance helps ensure overcharges by the subcontractor or purchase order price errors are processed into credits from the vendors. Finance or operations should verify that all the discounts earned are taken. Solid administrative processes such as these often have a substantial positive impact on inventory valuation.

A review of the invoice and purchase price variance will identify company processes and external events that impact the forecasted product cost. Assessment of these variances should uncover which of them will continue and in which amount. The analysis must not only be limited to the products generating the variance, but also to any other products using similar services or materials as they could also be impacted.

As mentioned, royalty is a significant cost often not included in the standard cost. The decision to enter into royalty agreements usually rests with sales or research and development (R&D). Finance can create some saving opportunities by considering volume discounts, prepaid royalties at discounted rates and negotiating end-of-life discounts for products becoming obsolete.

Inside costs are traditionally analyzed through variances. Yield variance and rework variance can identify poorly yielding products. Operations analysis includes a review of test programs and current standards, and considers both corrective measures and associated cost. Financial analysis should consider forecasted standard costs and if there are other potential costs resulting from yield issues. Potential costs could be rework and rescreen costs on inventory on-hand or with the customer as well as the cost of warranty replacements and customer claims for damages such as line-down penalties. There are additional impacts from yield and rework that require cooperation with sales to assess potential sales returns and to mitigate damages. Operations is often asked to consider the degree of vendor responsibility and decide if it would be possible to obtain credit. Even an unusually favorable variance should warrant a review. It could be the sign of issues such as a test program failing to catch defects.

A process variance can track when products follow a manufacturing route different from the standard route. Procurement standard cost is often blended in this scenario, estimating the volume percentage of each route or using the cost of the route with the highest expected volume. A significant variance should be analyzed to see why the change has occurred, to identify any operational issues or to determine if the standard needs to be reset.

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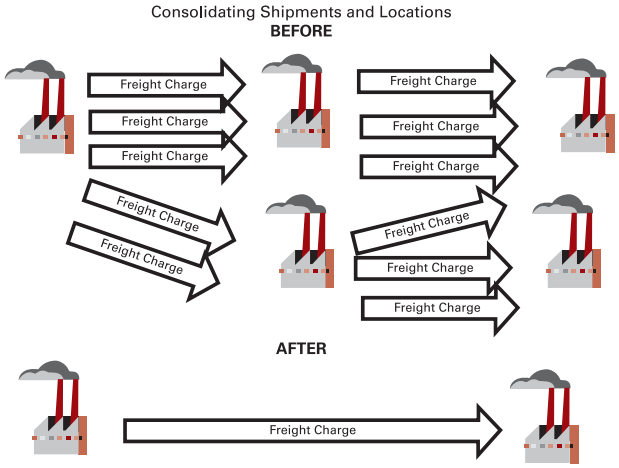
Inside costs such as physical inventory count variance can show significant bonus or scrap activity resulting from physical counts or simple inventory-level verifications. This can be a sign of internal process issues in operations or finance. Possible and common issues include data entry errors, incorrect reconciliation, failure to reconcile the enterprise resource planning (ERP) to the subcontractor records or incorrect subcontractor-provided data.

Warranty can also represent a significant part of cost. Warranty calculations usually use the general reserve method, the specific reserve method or a blend of both. Assumptions for these methods must be reviewed on a routine basis by finance and operations. Additionally, an inventory reserve can be used to identify slow moving items and obsolete items. Finance must work with sales to identify the possibility and the timing of fire sales and end-of-life notices with last-time-buy offers to customers.

Freight can provide saving opportunities for operations by consolidating shipments and reducing the number of subcontractor locations and freight companies to obtain better leverage on prices (see example model below). Finance and sales must create accurate production forecasts to avoid last-minute, small-order shipments. Expedite expenses and small lot charges often indicate problems in planning or ordering policies. Practices such as consistently accepting customer orders with delivery time shorter than lead time or having rescheduling policies too favorable to the customer often result in expedite charges. Operations, sales and finance need to work together closely to develop effective planning models.

Figure 2. Consolidating Freight



Overhead variances can be significant, and care must be taken to do a proper allocation of the operation department cost between R&D and cost of goods sold. Members of the operations department often have a dual role supervising pure manufacturing activities and working closely on R&D projects such as the tape-out of new chips. Manufacturing equipment, such as testers, are also often used for R&D projects. Finance often interviews operations team members to calculate and optimize the allocation. Other common charges under operations' control are probe card replacement, foundry certification costs, tester moving expenses, tester replacement for obsolescence and value-added tax (VAT) charges, among others.

Organizational Model

While the process of analyzing cost and variances provides valuable data, a company's significant challenge is to centralize all this data and turn it into a cost-saving action plan. In most companies, operations, sales and finance work in silos and are unable to reach an effective level of coordination. As such, the tone has to be set from the top, and the cost-saving initiative must be a continuous effort driven by upper-level management that includes a clear monitoring mechanism. An effective approach is to hold a series of quarterly, monthly and weekly status and goal-setting meetings.

The quarterly meetings are strategic meetings to be held with upper management, typically including the chief executive officer, chief financial officer, vice president of sales or marketing, and vice president of operations. These meetings are suited to set high-level future-saving targets—including expected timelines and a progress report on existing targets. Management should use these meetings to identify and address potential issues, take strategic corrective measures and readjust existing goals if necessary.

The monthly meetings are to be more tactical in nature and are held at the vice president and director level, typically including the vice president of operations, director of operations and controller. These meetings are used to create detailed action items to achieve the goals set in the quarterly meeting. They would also include a detailed review of progress made, existing issues and proposed corrective measures.

The weekly meetings typically involve the controller, cost accounting manager and director of operations and include a detailed review of each cost and variance, with a focus on identifying cost-saving opportunities, anticipating issues and finding solutions to current or new problems. The result of the meeting should be a weekly updated forecast showing expected results against the cost-saving plan.

Product cost saving is a continuous company-wide effort requiring not only good negotiations with outside vendors, but also upper management commitment, strong internal processes and careful, constant monitoring of the cost components. ■

Figure 3. The Cost-Saving Initiative

About the Authors

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