Using ABC to Support Continuous Improvement

National Semiconductor applies a two-pronged approach.

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In early 1991, National Semiconductor Corporation (NSC) embarked on its first implementation of activity-based costing (ABC). The goals of the pilot project were ambitious: to improve reported product costs *and* to provide information to guide improvement efforts—in several plants around the world.

In the first plant, the project team ran into immediate difficulty achieving these goals. To meet the improvement goal, NSC's managers wanted information that described the many facets of work in each area of the plant. But this required a detailed and complex model that was judged too costly and time-consuming to build.

As a result of these concerns, activity detail in the model was reduced to a summary level. This summary information was sufficient to report reasonably accurate product costs and thus meet the first goal. It was too aggregated, however, to provide insights about how and where to improve.

Results were disappointing. Despite a strong management commitment, and much attention to training, there was no evidence that ABC had any impact on improvement efforts.

In the second plant, NSC took a different approach to design. This second model included two different types of activities, micro and macro activities. Micro activities were detailed activities reflective of individual units of work and were intended to support activity improvement.[1]

Macro activities were summary activities. The costs of several related micro activities were assigned to a single macro activity. Macro activities were used for product costing and for assigning the cost of internal suppliers to their internal customers.

Prior to the completion of the project, lists of costed micro activities were distributed to the managers who

In this National Semiconductor factory, 20 improvements were made in one month in response to one piece of information.

had been interviewed previously. The managers were asked to confirm the correctness of the information prior to the completion of the model.

This single communication was unintentionally responsible for accelerating the pace and impact of improvements in the plant. Within a one-month period, it was found that more than 20 improvements had been made in response to the micro activity information. In addition, the NSC model reported accurate product costs at a reasonably low cost. Macro activities simplified the task of product costing and reduced the overall complexity of the model.

In this article we show how to design an ABC model to support continuous improvement. Using actual examples from NSC, we explain how a two-dimensional ABC model using micro and macro activities supplies the required information in an economical manner. How this information is used in the continuous improvement process also is described.

Based on our experience at NSC and elsewhere, we believe that this approach to ABC is the most significant development in the design of ABC models in recent years. It is the fulcrum on which ABC has moved from a narrow focus on product costing to a broader activity-based management perspective.

TWO-DIMENSIONAL ABC

Modern ABC models contain two dimensions: a cost view, and a process view (Figure 1). The presence of two dimensions extends ABC beyond product costing to the world of continuous improvement.[2]

The process view of ABC contains information about why work is done and how well it is performed. This information is used to assess the performance of work within the organization. Information provided about each activity or process includes cost drivers, performance measures, and other information—such as cost of quality—used in the continuous improvement process.

Cost drivers determine the workload and effort required to perform an activity. They include factors relating to the performance of supplier activities as well as factors internal to the activity. Performance measures describe the work done and the results achieved in an activity. They include measures of cost, quality, and time.

The cost view of ABC contains information about the cost of resources, activities, and products and customers. This information is used in strategic and tactical analyses, such as evaluating customer profitability, prioritizing improvement projects, and setting cost targets.

ABC uses two types of driver to assign cost to activities, outputs, and customers. *Resource* drivers assign the cost of resources to activities. For example, the resource driver "percent of effort" might be used to assign the cost of people to the activities they perform.

Activity drivers assign the cost of activities to products and customers. For example, the activity driver "number of purchase orders" might be used to assign the cost of the activity "preparing purchase orders" to the parts that are purchased.

MICRO/MACRO ACTIVITIES

The use of micro and macro activities allows two types of activity to be incorporated into the ABC model and the serving of two distinct customers of ABC information. The micro, or detailed activities, are part of the process view of ABC. The macro, or summary activities, are part of the cost assignment view of ABC.

Micro activities are the focal point of improvement efforts. Detailed cost and noncost information, including cost drivers and performance measures, is attached to micro activities. Micro activities are not used to cost products—the cost of micro activities is assigned to macro activities, not to products.

Macro activities are aggregations of related micro activities. Their primary purpose is to facilitate the reporting of accurate product costs, but they are too summarized to guide the improvement of individual activities.

The cost of a macro activity is assigned to products using a single activity driver, which reduces the cost and complexity of the ABC model because activity drivers are not attached to micro activities. It also maintains the accuracy of reported product costs because all micro activities within a macro activity are used in the same way by each product.

WAFER SORTING

The ABC design team at NSC built a micro/macro activity model for a wafer sorting process. This process took a thin slice of silicon (a wafer) and examined the dies on the wafer to see if any were defective. The team discovered seven micro activities within the process. They included writing die testing programs and handling batches of wafers before and after processing (Table 1). The team also discovered various micro activities in the support departments that sustained the sorting process. They included activities associated with providing materials to the process, such as placing purchase orders and bidding on new purchases.

No additional effort was required to identify these micro activities. Depart-

FIGURE 1/THE TWO-DIMENSIONAL ABC MODEL

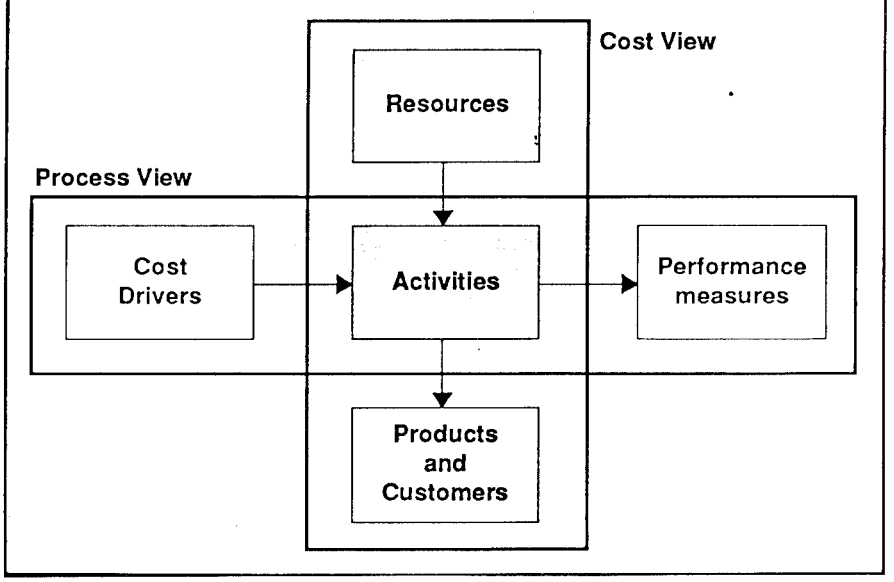


TABLE 1/DESIGN OF THE ABC MODEL FOR THE SORTING PROCESS
NATIONAL SEMICONDUCTOR CORPORATION

Micro Activity	Rule 1: Level	Rule 2: Activity Driver	Rule 3: Purpose	Macro Activity
Direct activities:				
Developing test programs	Product	Number of products	Sort direct	Developing/testing products
Making probe cards	Product	Number of products	Sort direct	Developing/testing products
Setting up lots	Batch	Number of lots	Sort direct	Handling wafer lots
Maintaining probe cards	Batch	Number of lots	Sort direct	Handling wafer lots
Testing products	Unit	Number of dies tested	Sort direct	Testing dies
Collecting engineering data	Batch	Number of lots	Sort direct	Handling wafer lots
Handling wafer lots	Batch	Number of lots	Sort direct	Handling wafer lots
Supplier activities:				
Providing indirect materials	Process	Use of materials	Sort sustaining	Providing materials
Purchasing materials	Process	Use of materials	Sort sustaining	Providing materials
Providing utilities	Process	Space	Sort sustaining	Providing space
Providing space	Process	Space	Sort sustaining	Providing space

ment managers supplied the micro activity information during the data-gathering process. Micro activities were equivalent to individual units of work in each department, so their description was a natural response to the question, "what work do you do?"

Interestingly, equivalent micro activity information was obtained from interviews in the first plant but was "thrown away" as unwanted detail. This time, however, the detail was retained and built into the model.

Various pieces of nonfinancial information—called attributes—were attached to the micro activities. The purpose of these items of nonfinancial information was to illuminate the improvement process.

Attributes included cost drivers; performance measures, value-added or nonvalue-added; and cost of quality. For example, the micro activities in the sorting process detected errors and were therefore tagged with the attribute "internal appraisal." This tagging of information in the ABC database facilitated the preparation of reports about the plant's cost of quality.

The costs of the seven micro activities within the sorting process were combined to make three process macro activities: testing dies, handling batches of wafers, and developing the tooling needed to test each type of wafer (Table 1). The costs of micro activities performed by internal suppliers were assigned to two separate macro activities: unit-based support and batch-based support.

The team followed three criteria in preparing macro activities.[3] Micro activities that met all three criteria were combined into a macro activity:

National Semiconductor worker tests silicon wafer as part of ABC.

- Only activities performed at the same level can be combined. Level relates to the output or customer of the activity. For example, testing an individual die (unit level), setting up the test equipment to test a batch of wafers (batch level), and developing a test program for a particular die (product level) could not be combined.[4]

It made sense to keep activities of different levels separate because the cost of activities at different levels varied in response to different factors. For example, the cost of the batch-level activity-testing wafers varied with the number of batches tested. By contrast, the cost of the product-level activity developing a test program varied with the number of different types of products tested.

- Activities that used the same activity driver could be combined without diminishing the reported accuracy of product costs. Activities that used different activity drivers could not be combined without dropping one or other of the drivers (only one activity driver per activity is possible in an ABC model[5]).

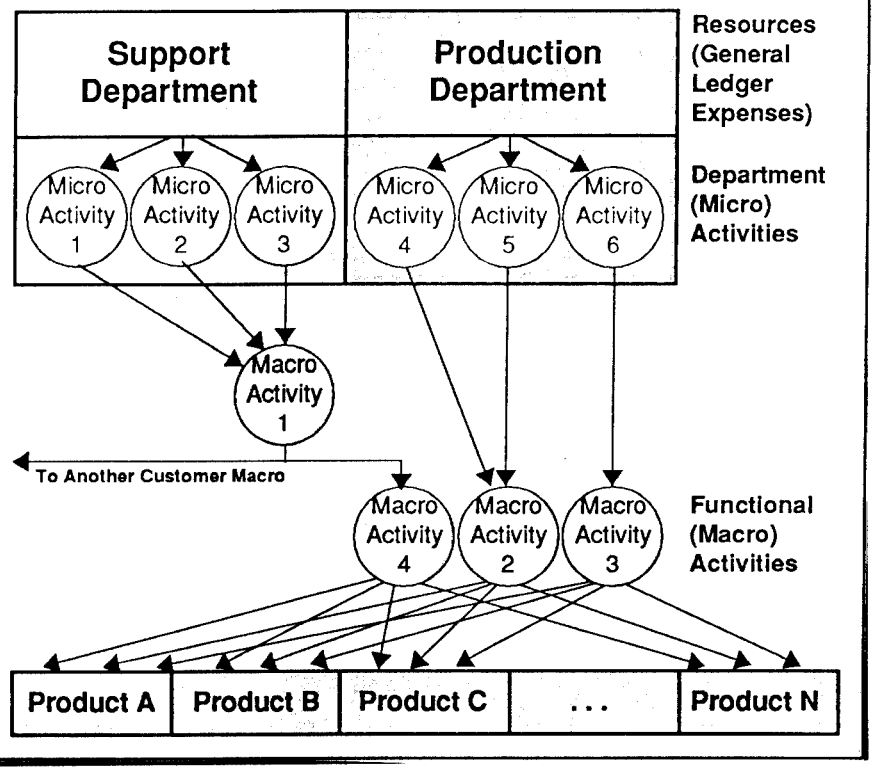
For example, the cost of setting up the test equipment and collecting test data was assigned using the activity driver "number of tests." These two activities therefore met rule 2.

The use of the testing dies activity was determined by the number of dies, not the number of tests. Its cost was therefore assigned to dies using the activity driver "number of dies" and could not be combined with the other activities that used different activity drivers.[6]

- Activities included in a macro activity had to be of common purpose or function. For example, some of the sorting activities, such as developing tests and maintaining probe cards, also were performed in other parts of the plant. These activities were part of a totally different process—and the responsibility of a different work team—and their cost was not assigned to a macro activity in the sorting process.

The costs of micro activities performed inside and outside the sorting process were assigned to separate macro activities because micro activities performed inside the process differed in level from those performed outside (rule 1). Those within the process sustained products, while those performed outside the process (supplier activities) sustained the process itself. For example, the activity providing indirect materials, performed in the purchasing department, helps sustain the sorting process (Table 1).

FIGURE 2/ACTIVITY-BASED COST MODEL USING MICRO AND MACRO ACTIVITIES.



TWO-DIMENSIONAL ABC AND MICRO/MACRO ACTIVITIES

The use of micro and macro activities changed the structure of the ABC model. The responsibility and economic aspects of the model were now kept separate, facilitating the model's dual product costing and performance improvement objectives. It also simplified the model, reducing the cost of system design and maintenance.

The Responsibility Model. The NSC model organized micro activities by department (Figure 2). The model assigned the cost of resources charged directly to a department to the micro activities within it. However, the model did not assign costs from other departments to these activities.

This micro activity structure paralleled the responsibility structure of the organization and supported process improvements in each jurisdiction. The micro activities within a department also corresponded directly to the resources charged to that department in the general ledger.

The micro activities in each department were grouped into departmental macro activities (according to the rules described above). Each macro represented a summary of similar activities. Each department macro activity also provided a starting point for improvement prioritization.

The Economic Model. Once the macro activities were established, the next step was to assign the cost of supplier activities to the sorting process (Figure 2). This assignment was based on estimates of their use and reflected an internal supplier-customer relationship. This cost assignment added economic meaning and utility to the model. First, each set of macro activities for a process contained all work performed within the process *and* the cost of supplier activities consumed by it. It included the cost of all work used in or by the process.

The ABC model therefore revealed the total cost of the sorting process—including the "hidden costs" of the process located elsewhere in the organization. This information could

be used, for example, in make-or-buy analyses on the sorting process or determinations of the cross-functional impact on cost of changes in the sorting process.

Second, it reduced the cost of reporting product costs because of the relative ease of assigning the cost of supplier activities to the processes that benefited. Usually, there was a clear supplier-customer relationship, and data measuring the use of supplier activities were readily available.

Once the cost was assigned to the customer process, the method of assignment to the products was easy. The cost of the support macro activity in each process was assigned using the primary activity driver in the process (such as the number of dies or the number of wafers).[7] The data for this driver already had been entered into the model to cost other activities in the process, so there was no additional data collection or data entry cost associated with the assignment.

In contrast, NSC previously had attempted to assign the cost of internal supplier activities directly to products. This was difficult because the relationship of the activity to products usually was not clear.

The benefits of this structure can be seen clearly when contrasted with the traditional two-stage cost assignment model (Figure 3).[8] The two-stage model, used in early ABC models, defined activities in only general terms. An activity was really a plant-wide cost pool reflecting a class of activity. Cost was assigned from any number of departments to a single cost pool. The cost of each cost pool was then assigned to products using an activity driver that best measured the consumption of that cost pool by the products.

The two-stage model reported more accurate product costs than traditional volume-based approaches. But its value for activity management and performance improvement was limited. One difficulty was the lack of detailed cost information about activities and the total lack of nonfinancial information. Another difficulty was the lack of responsibility of any one manager or department for a cost pool.

Two-stage models also were quite complex. The criss-crossing of cost assignment paths from departments to cost pools created a challenge when tracing cost from cost pools back to the originating departments.

MAJOR ADVANCE FOR COST MANAGEMENT

Two-dimensional activity-based costing is a major advance for cost management. It turns ABC into a true cost management system that supports product costing *and* performance improvement.

The key to building a two-dimensional ABC model is to use micro and macro activities. Micro activities are the units of work in a department that are managed on a day-by-day basis. Macro activities are summaries of work that facilitate reporting accurate product costs and yield the cost of internal supplier-customer relationships.

NSC's ABC model is a good example of two-dimensional design. It shows how micro activities are combined into macro activities using three rules. It reveals a two-level model structure that includes both responsibility and economic information.

The NSC model does not illustrate all possible design alternatives. For example, the micro activities in the NSC model are organized by department. Some firms, however, choose to organize micro activities by cross-functional process.

An apparently simple design innovation, the two-dimensional model with micro and macro activities is a boon for ABC system designers. In addition to improving the quality and flexibility of ABC information, it reduces the cost and complexity of ABC models. ■

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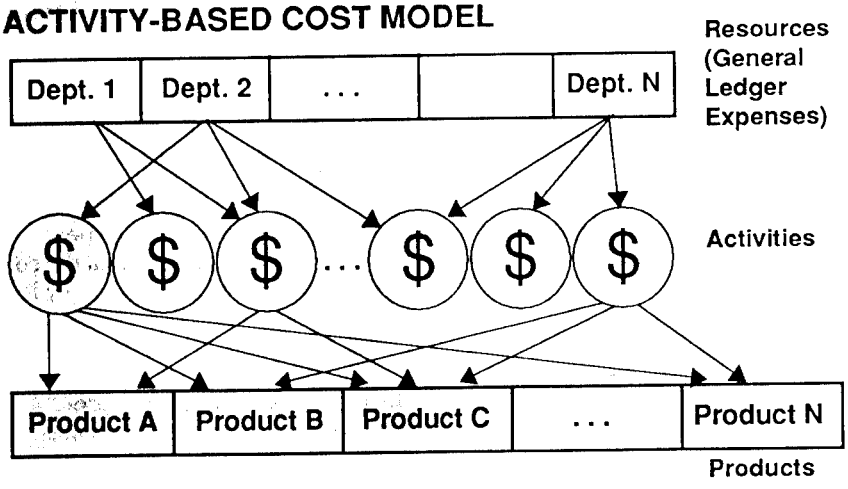
FIGURE 3/DESIGN OF A TWO-STAGE ACTIVITY-BASED COST MODEL



[1]Information about the tasks that underlay each activity was not included in the model. It was expected that this information would be developed by the users in response to their need for detailed activity information.

[2]See Chapters 4, 5, and 6 of Peter B.B. Turney, *Common Cents: The ABC Performance Breakthrough*, (Portland: Cost Technology, 1992) for an extended discussion of two-dimensional ABC.

[3]These criteria were based on the rules for the design of macro activities in *Common Cents: The ABC Performance Breakthrough*, p. 126.

[4]Unit, batch, product, and process activity levels were first described by Robin Cooper in "Cost Classification in Unit-Based and Activity-Based Manufacturing Cost Systems," *Journal of Cost Management*, Fall 1990, pp. 4-14. See *Common Cents: The ABC Performance Breakthrough*, pp. 146-150, for a complete discussion of activity levels.

[5]See *Common Cents: The ABC Performance Breakthrough*, pp. 281-284, for a discussion of the rules of selecting activity drivers.

[6]Testing dies is also a unit level activity, so it also fails rule 1 as a candidate for combining with the other two testing activities.

[7]Assigning the cost of an activity such as "providing facilities space" to products using the "number of dies" as the activity driver is not theoretically correct. (The activity is processing sustaining, and the activity driver is unit-level). However, from a practical standpoint it makes sense. First, space is clearly consumed by the process. Second, the amount of space required by the sorting process is determined primarily by the volume of dies. Third, there is no theoretically correct answer.

[8]See, for example, Robin Cooper, "The Two-Stage Procedure in Cost Accounting: Part One," *Journal of Cost Management*, Vol. 1, No. 2, Summer 1987, pp. 43-51.

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