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# Introduction to Activity-Based Costing

In this note, we introduce activity-based cost (ABC) systems. The motivation for ABC systems is simple to articulate. Consider two hypothetical and almost identical factories. Single Factory makes one million pens, all the same color: blue. Multi Factory also makes one million pens, but of many different colors, sizes, and varieties. This factory, in a typical year, produces about 2,000 different types (SKUs) of pens, ranging from specialty pens, with annual production volume as low as 50-100 per year, to higher-volume standard pens (blue and black), whose annual production volumes are each about 100,000 per year.

Even though both factories make the same basic product, Multi Factory requires many more resources to support its highly varied mix. Relative to the blue pen factory, Multi Factory would have much larger production support staff, requiring more people to schedule machines and production runs, perform setups, inspect items after setup, move materials, ship orders, expedite orders, rework defective items, design new products and improve existing products, negotiate with vendors, schedule materials receipts, order, receive, and inspect incoming materials and parts, and update and maintain the much larger computer-based information system. Multi Factory would also operate with considerably higher levels of idle time, setup time, overtime, inventory, rework and scrap. Since both factories have the same physical output, they would both have roughly the same cost of materials (ignoring the slightly higher acquisition costs in Multi Factory for smaller orders of specialty colors and other materials). For actual production, if you assume that all pens are of about the same complexity, both Single and Multi Factory would require the same number of direct labor hours and machine hours for actual production (not counting the higher idle time and setup times in Multi Factory). Multi Factory would likely also have about the same property taxes, security costs, and heating bills as Single Factory. But Multi Factory would have much higher indirect and support costs (i.e., overhead) because of its more varied product mix and complex production task.

Consider now the operation of a typical standard cost system in these two plants. Single Factory has little need for a cost system to calculate the cost of a blue pen. The financial manager, in any single period, can simply divide total expenses by total production volume to get the cost per blue pen produced. For Multi Factory, the costs of the indirect and support expenses would be traced to its various production cost centers. Once expenses are accumulated in each production center, they would be applied to products based on the cost driver for that cost center: direct labor, machine hours, units produced, or materials quantity processed. On a per unit basis, high-volume standard blue and black pens require about the same quantity of each of these cost drivers as the very low volume, specialty products. Therefore, Multi Factory's overhead costs would be applied to products

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Professor Robert S. Kaplan prepared this note as the basis for class discussion.

proportional to their production volumes. Blue and black pens, each representing about 10% of the plant's output, would have about 10% of the plant's overhead applied to them. A low volume product, representing only .01 of 1% of the plant's output (100 pens per year), would have about .01 of 1% of the plant's overhead allocated to it. Therefore, the standard costing system would report essentially identical product costs for all products, standard and specialty, irrespective of their relative production volumes.

Clearly, however, considerably more of Multi Factory's indirect and support resources are required (on a per-unit basis) for the low-volume, specialty, newly designed products than for the mature, high-volume, standard blue and black pens. Traditional cost systems, even those with hundreds or thousands of production cost centers, will systematically and grossly under estimate the cost of resources required for specialty, low-volume products and will over estimate the resource cost of high volume, standard products (see **Exhibit 1**). The distortion in reported costs between standard and specialty products can be avoided only if the standard and specialty pens are manufactured on separate machines in different cost centers.

Abandoning the assignment of support resource costs entirely and moving to direct costing systems does not solve this problem. Under direct or marginal costing, blue and black pens, which have about the same materials and direct labor cost as the low-volume, specialty pens, will have the same variable costs. Also, direct costing systems fail to explain why the two factories with exactly the same physical units of production (e.g., one million pens) have dramatically different levels of "fixed costs."

Activity-based cost systems extend traditional cost systems by linking resource expenses to the variety and complexity of products produced, not just the physical volumes produced. We can think of ABC as providing the answer to the following four questions:

### *1. Why is the organization spending money on indirect and support resources?*

The answer to this question, of course, is that the spending on indirect and support resources is necessary because of the activities performed (for example, scheduling, purchasing, customer administration, and improving products) or the capabilities being supplied by these resources (such as information technology and suitable production and customer support space). So the focus has already shifted from how to allocate costs (the question answered by traditional cost systems) to why is the organization spending money in the first place (the ABC initial question). As the organization answers this initial question, it identifies the set of activities being performed by its indirect and support resources. Activities are described by verbs and objects: schedule production, move materials, purchase materials, inspect items, respond to customers, improve products, introduce new products, etc. The identification of activities culminates with construction of an activity dictionary that lists and defines all the major activities performed in the production facility.

In some initial applications, engineers and accountants defined activities at a very micro level, perhaps at an individual task level, leading to several hundred or more activities. This was both expensive and confusing. Now, ABC project teams use rules of thumb, such as to ignore activities that use less than 5% of an individual's time or a resource's capacity. Activity dictionaries can be relatively brief, say 10-30 activities, especially where the prime focus of the ABC system is to estimate product and customer costs. In other applications, ABC systems continue to be built with hundreds of activities. Typically, such highly detailed systems have been constructed to serve as the foundation for process improvement and process redesign efforts. The number of activities, therefore, is a function of the purpose of the model and the size and complexity of the organizational unit being studied.

The second question answered by an ABC system is:

## *2. How much is the organization spending on each of its activities?*

To answer this question, the ABC system maps, from resource expenses to activities, using resource cost drivers. The resource cost drivers link spending and expenses, as captured in the organization's financial or general ledger system, to the activities performed. Resources are the initial building block of both traditional and ABC cost systems.

Classifying resource expenses by activities performed accomplishes a 90° shift in thinking about expenses (see **Exhibit 2**).

Data from the organization's financial system categorizes expenses by spending code; for example, salaries, fringe benefits, overtime, utilities, indirect materials, travel, telecommunications, computing, maintenance, and depreciation. The resource cost drivers (see **Exhibit 3**) collect expenses from this financial system and drive them to the activities being performed by the organizational resources. Thus, after going through this step, organizations learn, usually for the first time, how much they are spending on activities like *purchase materials*, and *introduce new products*.

The actual mechanics of selecting resource cost drivers and estimating the quantity of each resource cost driver are reasonably well documented in several books that describe the details of implementing ABC systems. Typically, the ABC analyst interviews or surveys employees. They may give employees a survey form with the activity dictionary, and ask them to estimate the percentage of time they spend on any activity (in excess, say, of 5% of their time) on the list.

For nonpersonnel resources, the ABC project team either relies on direct measurement (how much power, computer or telecommunications time) or estimates the percentage of the resource used by each activity in the dictionary. ABC systems, like traditional systems, drive expenses to production cost centers—where the activity is part of the actual product conversion process like *fabricate parts*, *mix chemicals*, or *assemble products*. But, in addition, the ABC system drives operating expenses to activities that are not directly involved in converting materials into intermediate and finished products, like *setup machines*, *schedule production runs*, and *perform engineering change notices.* Traditional cost systems, in contrast, drive the expenses of such activities to production cost centers where they get arbitrarily allocated to products proportional to production volumes.

One does not need extensive time-and-motion studies to link resource spending to activities performed. The goal is to be approximately right, rather than precisely wrong, as are virtually all traditional product costing systems. Many traditional standard cost systems calculate product costs out to six significant digits ($5.71462 per unit) but, because of arbitrary allocation procedures, the first digit is wrong.

### *Hierarchy of Activities*

Once resource costs have been traced to activities, managers get powerful insights from identifying critical attributes of the activities. One of the most important attributes classifies manufacturing activities along a cost hierarchy dimension: unit, batch, and product, customer, and facility sustaining.

**Unit-level activities** are activities performed for every unit of product or service produced. The quantity of unit-level activities performed is proportional to production and sales volumes. Examples include drilling holes in metal parts, grinding metal, and performing 100% inspection.

Traditional cost systems, which use allocation bases such as labor hours, machine hours, units produced, or sales dollars to assign indirect costs to cost objects, rely exclusively on unit-level cost drivers. One of the principal differences between activity-based and traditional cost systems is the use of non-unit cost drivers (e.g., batch, product sustaining) for assigning resource costs to products and customers.

**Batch-level activities** are those performed for each batch or setup of work performed. Batch activities include setting up a machine for a new production run, purchasing materials, and processing a customer order.

The resources required for a batch-level activity are independent of the number of units in the batch (number of components produced after a setup, number of items in a purchase order, or the number of products in a customer shipment). Activity-based cost systems measure and assign the cost of handling production orders, material movements, setups, customer orders, and purchasing to the products, customers, and services that triggered the activity.

**Product-sustaining activities** are performed to enable the production of individual products (or services) to occur. Extending this notion outside the factory leads to **customer-sustaining activities** that enable the company to sell to an individual customer but that are independent of the volume and mix of the products (and services) sold and delivered to the customer. Examples of these product- and customer-sustaining activities include maintaining and updating product specifications, special testing and tooling for individual products and services, and technical support provided for individual products and to service individual customers.

Product- and customer-sustaining activities are easily traced to the individual products, services, and customers for whom the activities are performed. But the *quantity* of resources used in product- and customer-sustaining activities are, by definition, independent of the production and sales volumes and quantity of production batches and customer orders. Traditional cost systems, relying only on unit-level drivers, cannot trace product and customer-sustaining resources to individual products and customers.[1]

The ABC cost hierarchy enables all organizational expenses to be mapped to a particular hierarchical or organizational level where cause and effect can be established. That is a customer-sustaining expense is not allocated to the products or services purchased by that customer, since this expense is incurred independent of the volume and mix of products or services acquired by this customer. The customer-sustaining expense can be avoided or controlled only by operating at the customer level (dropping the customer, changing the level of support provided to the customer), not by changing the volume or mix of the individual products and services the customer acquires.

The batch, product-sustaining, and customer-sustaining categories give powerful insights into why two facilities, like the two pen factories, that have identical total physical outputs could have drastically divergent cost structures. Both Single (blue pen) Factory and Multi Factory have the same quantity of unit-level activities, since they have the same physical output of 1 million pens per year. They also likely have the same level of facility-sustaining expenses (assuming that all non-

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[1] Beyond unit, batch, product, and customer-sustaining activities, other resources supply capabilities that could not be traced to individual products and customers. Some activities, such as product development and advertising, can be classified as **brand** or **product-line sustaining** since they support an entire brand or product line. Others provide general production or sales capabilities. **Facility-sustaining** expenses, such as a plant manager and administrative staff, and **channel-sustaining** expenses—trade shows and advertising, catalogs—can not be traced to individual products, services, or customers. The expenses of product-line, facility, and channel resources can be assigned directly to the individual product-lines, facilities, and channels but should not be allocated down to individual products, services, or customers within these product lines, facilities, and channels.

manufacturing costs occur outside the factories). But Multi Factory, producing thousands of products, ranging from low-volume, specialty products to high-volume blue and black pens, requires far more resources than Single Factory to perform the additional batch and product-sustaining activities required by the many different products and production runs.

In summary, at the end of the second phase of building an ABC model, the organization knows expenses characterized by activities performed. Already at this stage, organizations have new information that can be used for a range of activity and process improvement actions. But before turning to how ABC information can be used, let's continue with the construction of the first full ABC model. For the next phase, we answer a third question about why ABC?

### 3. *Why is the organization performing activities?*

Answering the first two questions identifies the activities being performed and the cost of performing those activities. The answer to the third question, of course, is that the organization has to perform activities to design, build, and deliver products and services to its customers. Therefore, in answering this third question, the ABC project team identifies all the organization's products, services, and customers. Initially, since we are focusing on analyzing the indirect and support costs of manufacturing facilities, we will focus on driving costs to products, deferring the assignment of activity costs to services and customers to later in the course.

The answer to question number 3 was simple, though even asking this question has eluded some practitioners of activity-based costing. These practitioners have focused only on how to make activities and processes more efficient, but have not asked the more fundamental question as to whether these activities or processes are worth doing. Is the organization getting paid adequately for performing these activities? To determine whether the organization is being compensated for performing activities requires that activity costs be linked to the products, services, and customers who are the ultimate beneficiaries of the organization's activities. Addressing this issue leads naturally to the fourth question to which ABC systems provide the answer.

### 4. *How much of each activity is required for the organization's products, services, and customers?*

The linkage between activities and cost objects, such as products, services, and customers, is accomplished using activity cost drivers. An activity cost driver is a quantitative measure of the output of an activity. Examples of typical activity cost drivers for particular activities are shown on the list below:

| **Activity** | **Activity Cost Driver** |
|---|---|
| Run machines | Number of machine hours |
| Setup machines | Number of setups or setup hours |
| Schedule production jobs | Number of production runs |
| Receive materials | Number of material receipts |
| Support existing products | Number of products |
| Introduce new products | Number of new products introduced |
| Maintain machines | Number of maintenance hours |
| Modify product characteristics | Number of engineering change notices |

**Exhibit 3** shows the overall structure of an activity-based cost model, linking one resource—indirect labor—to the activities performed and then, via activity cost-drivers, to cost objects, such as products.

## *Selecting Activity Cost Drivers*

The selection of an activity cost driver reflects a subjective trade-off between accuracy and the cost of measurement. Because of the large number of potential activity-to-output linkages, designers attempt to economize on the number of different activity cost drivers. For example, activities triggered by the same event—prepare production orders, schedule production runs, perform first part inspections, and move materials—all can use the same activity cost driver: number of production runs or lots produced.

ABC system designers can choose from three different types of activity cost drivers:

*Types of Activity Cost Drivers*

1. Transaction
2. Duration
3. Intensity or Direct charging

**Transaction drivers**, such as the number of setups, number of receipts, and number of products supported, count how often an activity is performed. Transaction drivers can be used when all outputs make essentially the same demands on the activity. For example, scheduling a production run, processing a purchase order, or maintaining a unique part number may take the same time and effort independent of which product is being scheduled, which material is being purchased, or which part is being supported in the system.

Transaction drivers are the least expensive type of cost driver but could be the least accurate, since they assume that the same quantity of resources is required every time an activity is performed; that is, the activity is homogeneous across products. For example, the use of a transaction driver like the number of setups assumes that all setups take the same time to perform. For many activities, the variation in use by individual cost objects is small enough that a transaction driver will be fine for assigning activity expenses to the cost object. If, however, the amount of resources required to perform the activity varies considerably, from product to product, then more accurate and more expensive cost drivers are required.

**Duration drivers** represent the amount of time required to perform an activity. Duration drivers should be used when significant variation exists in the amount of activity required for different outputs. For example, simple products may require only 10-15 minutes to setup, while complex, high-precision products may require 6 hours for setup. Using a transactions driver, like number of setups, will overcost the resources required to setup simple products and will undercost the resources required for complex products. To avoid this distortion, ABC designers would use a duration driver, like setup hours, to assign the cost of setups to individual products.

Examples of duration drivers include setup hours, inspection hours, and direct labor hours. For materials movement, distance moved can be viewed as a duration driver; distance acts as a proxy for the time taken to move materials from one point to another. In general, duration drivers are more accurate than transactions drivers, but they are much more expensive to implement since the model requires an estimate of the duration each time an activity is performed. With only a transaction driver (number of setups), the designer would only need to know how many times a product was setup,

information that should be readily available from the production scheduling system. Knowing the setup time for each product is an additional, and more costly, piece of information. The choice between a duration and a transactional driver is, as always, one of economics, balancing the benefits of increased accuracy against the costs of increased measurement.

For some activities, however, even duration drivers may not be accurate. **Intensity drivers** directly charge for the resources that are used each time an activity is performed. Continuing with our setup example, a particularly complex product may require special setup and quality control people, as well as special gauging and test equipment each time the machine is setup to produce the product. A duration driver, like setup cost per hour, assumes that all hours are equally costly, but does not reflect extra personnel, especially skilled personnel and expensive equipment that may be required on some setups but not others. In these cases, activity costs may have to be charged directly to the output, based on work orders or other records that accumulate the activity expenses incurred for that output.

Intensity drivers are the most accurate activity cost drivers but are the most expensive to implement; in effect they require direct charging via a job order costing system to keep track of all the resources used each time an activity is performed. They should be used only when the resources associated with performing an activity are both expensive and variable each time an activity is performed.

The choice among a transaction, duration, or direct charging (intensity) cost driver can occur for almost any activity. For example, for performing engineering change notices (to upgrade and support existing products), we could use:

- cost per engineering change notice (assumes every ECN consumes the same quantity and cost of resources),
- cost per engineering change hour used for the ECN done for an individual product (allows for ECNs to use different amounts of time to perform but assumes every engineering hour costs the same), or
- cost of engineering resources actually used (number of engineering hours, price per hour of engineers used, plus cost of equipment such as engineering workstations) on the job.

Similarly for a sales activity, like support existing customers, we could use either a transaction, duration, or intensity driver; e.g.,

- cost per customer (assumes all customers cost the same)
- cost per customer hour (assume different customers use different amounts of sales resource time, but each hour of support time costs the same)
- actual cost per customer (actual or estimated time and specific resources committed to specific customers).

Activity cost drivers are the central innovation of activity-based cost systems but they are also the most costly aspects of ABC systems. Often project teams get carried away with the potential capabilities of an activity-based cost system to capture accurately the economics of their organization's operations. The teams see diversity and complexity everywhere and design systems with upwards of 500 activities. But in selecting and measuring the activity cost drivers for such a system, a reality check takes hold. Assume that each different activity requires a different activity cost driver, and that the organization has, say, 5,000 individual products and customers (not an atypically

low number for many organizations). The analyst would have to enter up to 2,500,000 pieces of information (500 x 5,000), the quantity of each activity cost driver used by each individual product and customer. This is why most ABC systems for product and customer costing purposes try to have no more than 30 to 50 different activity cost drivers, most of which can be accessed and traced to individual products and customers relatively simply in their organization's existing information system.[2]

## *Where to Apply Activity-Based Cost Systems*

When will activity-based cost systems have the greatest impact? Or, asking this question another way, where should an organization look initially to demonstrate the potential benefits from building an activity-based cost system? We have found that two simple rules help to guide the search for high-potential ABC applications:

1. The Willie Sutton rule:[3] Look for areas with large expenses in indirect and support resources, especially where such expenses have been growing over time. Operations where almost all expenses are direct labor and direct materials, which can already be directly traced to individual products by traditional costing systems, may have less need for ABC systems. In effect, if organizational activities are all at the unit level (virtually no batch or product-sustaining activities), then ABC systems and traditional cost systems will likely give very similar economic signals.

2. High Diversity: Look for a situation in which large variety exists in products, customers, or processes. For example, consider a facility that produces mature and newly introduced products, standard and custom products, high-volume and low-volume products. For marketing and selling expenses, companies may have a mixture of customers who order high-volume, standard products with few special demands as well as customers who order in small volumes, special products, and require large quantities of pre-sales and post-sales technical support.

Not all organizations fall within the Willie Sutton rule. Take the example of an early Apple Computer factory that had been designed for automatic, high-efficiency assembly operations. The factory did only final assembly operations. It did no component or parts fabrication and no sub-assembly operations. As a result, more than 90% of the factory expenses were for purchased parts, equipment, and a small amount of direct labor. In this case, direct charging for labor, materials, and machine time, a process done well by a traditional cost system, would work fine. The indirect and support expenses were extremely small, since the factory had been designed for focused, unit-level operations. The Willie Sutton rule would have directed ABC designers at Apple to focus on product development, marketing, distribution, and selling expenses not on factory overhead.

The high diversity rule is violated by Single Factory, making only a single product–blue pens. When a factory produces only a single product, then all of its manufacturing expenses are easily

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[2] With many organizations installing data warehouses and integrated, enterprise resource planning (ERP) systems is that many more potential activity cost drivers become automatically available for ABC systems.

[3] Willie Sutton was a successful bank robber in the United States during the 1950s. Willie, who was eventually captured at his home not far from a local police station, was asked during his initial interrogation, "Why do you rob banks?" Willie replied, with the wisdom that had made him successful for many years, "That's where the money is!" When developing ABC systems, we should follow Willie's sage advice (but not his particular application of the insight) to focus on high cost areas where improvements in visibility and action could produce major benefits to the organization. Applying an ABC analysis to a set of resource expenses that are below 1% of total spending will not lead to high payoffs to the organization.

attributable to that product. The organization does not need an ABC system, in fact any system, to calculate its product costs. Just take manufacturing expenses and divide by number of items produced (or producible, as we will see later) to obtain an accurate estimate of the unit product cost.

Even in highly focused factories, however, where product costing is not a major concern, some organizations have still benefited from building ABC models to give visibility to their underlying process costs. For example, an early ABC implementation occurred in a defense factory that made only a single product; a complex weapon system consisting of tens of thousands of parts. Thus all costs were easily associated with production of that system. The plant's management team wanted an ABC model so that they could understand better the costs of all the activities and processes used to produce the weapon system. So the diversity of processes was sufficient to create a demand for the more accurate attribution of costs, in this case to activities and processes, that an ABC model can provide.

## *ABC: Lowest Cost System, Not the Most Accurate One*

The goal of a properly constructed ABC system is not to have the most accurate cost system. Consider a target (see **Exhibit 4**), where the bulls-eye represents the actual cost of resources used each time a product is made, a service delivered, and a customer served. To hit this bulls-eye each time requires an enormously expensive system. But a relatively simple system, perhaps with 30 to 50 activities and using mostly transactions drivers, should enable the outer and middle rings of the target to be hit consistently; that is, activity and process costs will be accurate to within 5% or 10%. Traditional cost systems virtually never even hit the target, or even the wall on which the target is mounted, as their highly distorted costs are like firing a shotgun at a barn but shooting directly up in the air or to the sides. Good engineering judgment should be used; most of the benefits from a more accurate cost system can be obtained with relatively simple ABC systems.

A properly constructed ABC model should represent an economic model or map of the organization's expenses. And perhaps people would be less confused about what the purpose of an ABC system is if we called it an activity-based economic map. An ABC system is like a map or a set of architectural drawings. Can one drive from one location to another without a map? Can one build a house without a set of architectural drawings? Absolutely. If a manager is working in familiar territory (either a drive we've taken or a house we have built hundreds of times before), then the manager can rely on experience and good judgment for a successful outcome. But when the territory is new, and conditions have changed in important ways from prior experience, that's when an information system like a good map or a good set of drawings become invaluable.

For companies operating in stable environments, with mature products that the company has extensive experience producing, and with stable customer relationships, the company's traditional cost system, or perhaps no cost system, is fine to guide operations. But when the company is now producing many new products, introducing new processes, reaching new customers, and satisfying many more customer demands, then it would be easy for the company to get lost, economically, as it operates in the new environment. An activity-based cost system provides companies with an economic map of their operations by revealing to them the cost of activities and business processes, leading to knowledge of the cost and profitability of individual products, services, customers, and operating units.

The map produced by traditional cost systems looks like the Great Plains in the U.S. midwest. The terrain looks the same in whatever direction you look. No guidance is provided to managers about where to land and devote their energy and attention. The map produced by an ABC system looks like the southeastern part of California, making visible the Sierra Madre peaks of profitable products and

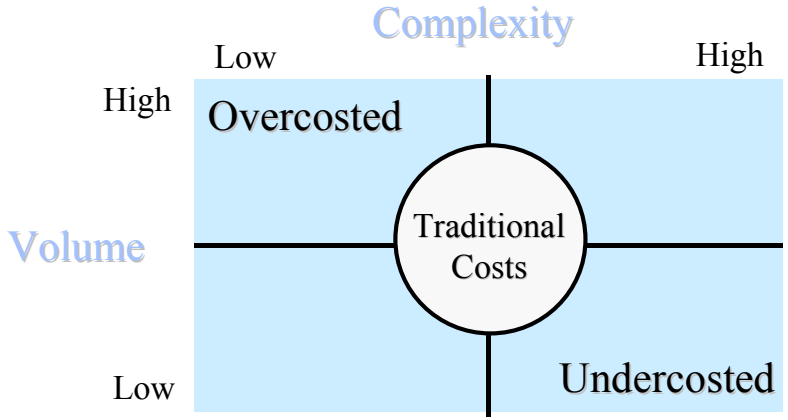
the Death Valley craters of losses. Managers get much more direction about where and how their scarcest resource—energy, time, and attention—act to bring the craters of Death Valley losses to at least sea-level (break-even), and eventually to modest hills of profitability.

## *Summary*

Traditional cost systems, using only unit-level cost drivers such as direct labor hours, direct labor dollars, machine hours, and units produced, cannot capture the economics of complex, multi-product production processes. Activity-based cost systems provide more accurate cost information about business activities and processes, and of the products, services, and customers served by these processes. ABC systems focus on organizational activities as the key element for analyzing cost behavior in organizations by linking organizational spending on resources to the activities and business processes performed by these resources. Activity cost drivers, collected from diverse corporate information systems, then drive activity costs to the products, services, and customers that create the demand for (or are benefiting from) the organizational activities. These procedures produce good estimates of the quantities and the unit costs of the activities and resources deployed for individual products, services, and customers.

**Exhibit 1**

## Traditional Systems Distort Product and Customer Costs




### Product Complexity

- Small batch sizes
- Long set-up times
- Unique components
- Special inspection and tests
- Extensive material handling
- Special vendors

### Customer Complexity

- Customized products
- Short lead times
- Unpredictable orders
- Extensive technical support
- Extensive post-sales support
- Special tests and requirements

Exhibit 2

# Activity-Based Costing: From Expense Categories to Activities

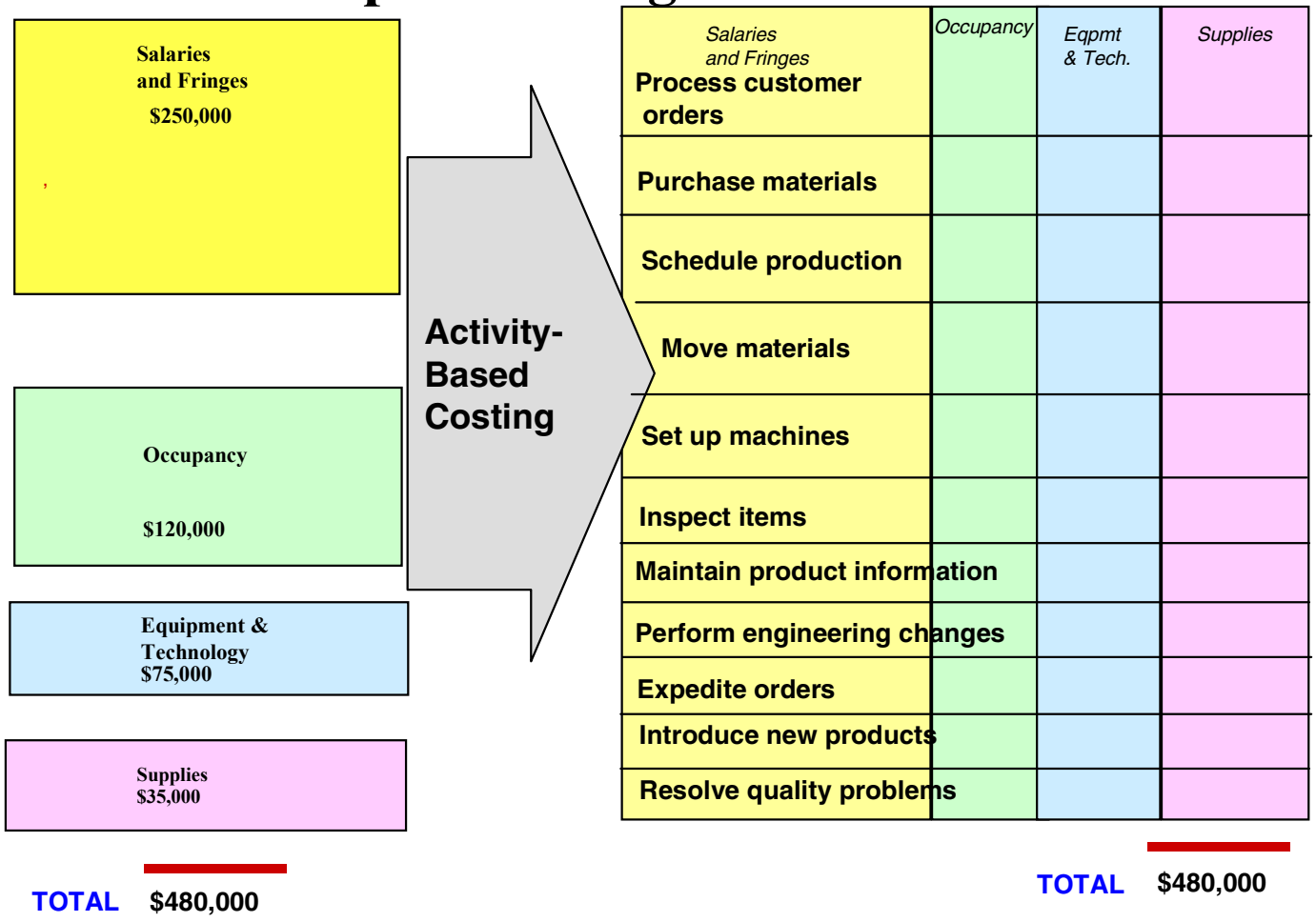


Exhibit 3

# ABC: Expenses Flow from Resources to Activities to Products, Services and Customers

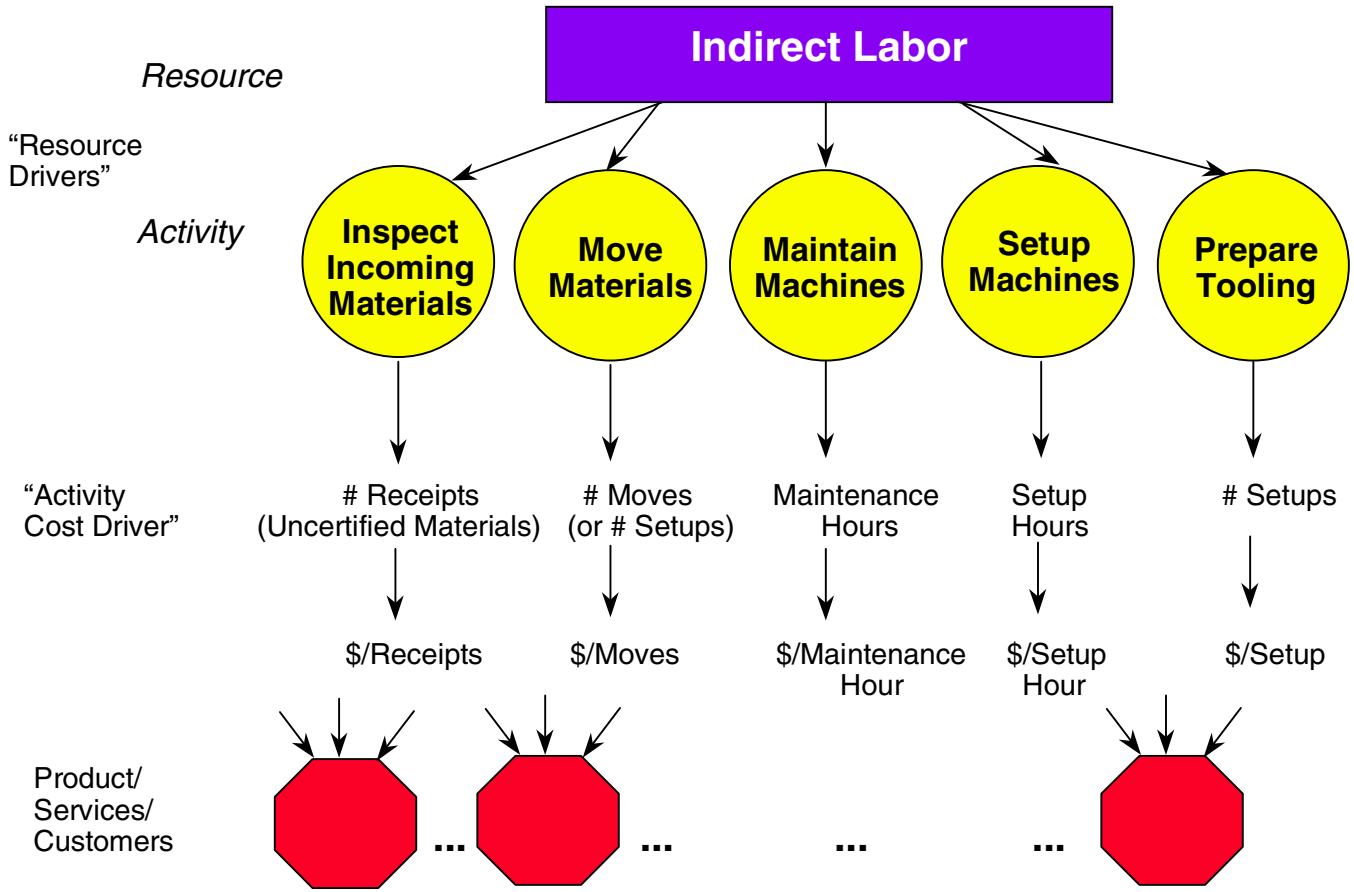


**Exhibit 4**

## Cost Accuracy Target