3

Assigning Resource Costs to Production Cost Centers

All cost systems start by assigning resource expenses to cost centers. Data from the organization's financial systems, either the general ledger or the budgeting system, categorize resource expenses by spending code: for example, salaries, fringe benefits, overtime, utilities, indirect materials, travel, telecommunications, computing, maintenance, and depreciation. Expense information from the general ledger is used to assign actual expenses recognized during the period to cost centers and subsequently to products.[1] The ex post assignment of actual costs is used to monitor actual efficiencies and profitability. Expense information from the budgeting system is assigned on an ex ante basis to develop standard costing rates that can be used, during the period, for decision making on consumption of services, pricing, and customer-related decisions. The design and structure of the cost system, however, remain the same whether budgeted or actual resource expenses are being assigned.

Companies organize the recording of resource expenses so that they can be classified by an organizational unit, let us call it a responsibility center, that has direct responsibility for the resource. For example, the expense of providing power would be recorded in the company's utility or power department, the expense of a maintenance worker and supplies and equipment used by the worker would be assigned to the maintenance department, and the expenses of a particular machine would be assigned to the operating department in which the machine is located.

Organizations typically have two types of departments: *production departments*, which directly produce or distribute the firm's outputs, and *service departments*, whose main output is to provide service to other departments. Examples of production departments include machining centers, assembly departments, data transport departments, and check processing departments. Examples of service departments include utilities, maintenance, purchasing, scheduling, production control, stockroom, materials handling, housekeeping, customer order handling, and information systems.

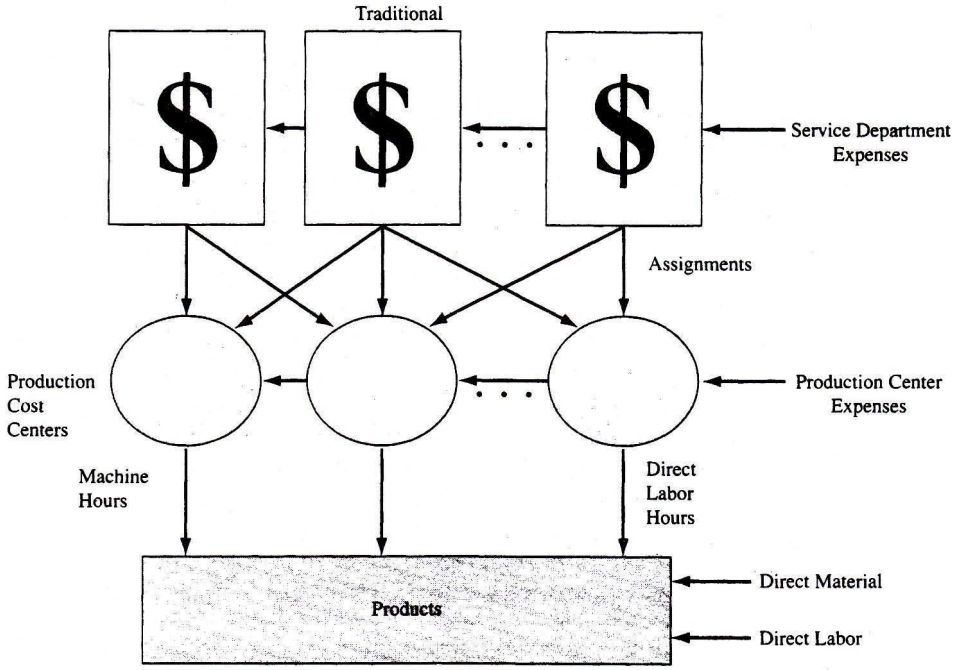

EXHIBIT 3-1 Traditional Two Stage Cost System: Assigning Service Department Costs to Production Centers and Products

Traditional cost systems have the simple two-stage structure shown in Exhibit 3.1. In the first stage, service department costs are assigned to production or operating departments. In addition, the costs directly arising in these production departments are directly traced to these departments. Thus, after the first stage, all organizational expenses are assigned, either directly or through assignment from service departments, to production departments. In the second stage, shown in Exhibit 3.1, costs are assigned from production departments to the products processed through those departments. The first stage of an activity-based cost (ABC) system has the same structure as a traditional cost system, though instead of assigning service department resource costs to production centers, ABC systems assign resource expenses of both production and service departments to the activities performed by those resources.

In this chapter, we discuss the first-stage process, the assignment of resource expenses to production departments. In Chapter 4, we expand the discussion to ABC systems, in which many resource expenses get assigned to activities as well as to production cost centers. We will also discuss, in Chapter 4, the second-stage process, in which production department and activity costs are assigned to products.

WHY ASSIGN SERVICE DEPARTMENT COSTS?

Service department costs are assigned to production departments for two purposes: (1) cost control and efficiency and (2) reassignment to products that flow through the produc-

tion departments. For this chapter, we will focus on the cost control and efficiency story. In assigning costs for this purpose, it will be important, as we shall see, to distinguish costs that are short-term variable (these are costs associated with flexible resources) from costs that are fixed in the short term (that is, the costs associated with committed resources). When we turn to activity-based costing (ABC) in Chapter 4, these distinctions become less important because the role for ABC is to direct managers' attention to actions that influence decisions about both flexible and committed resources. Also, systems for cost control and efficiency require accurate measurements of the resources supplied and used by different departments in an organization. For the ABC system, estimates of resources used may be sufficient to guide managerial decision making. In general, companies need both types of systems: systems for monitoring and controlling short-term spending and expenses as well as ABC systems for measuring the cost of activities and the cost and profitability of products, services, customers, and business units.[2] With these differences articulated, we can now concentrate on assigning support department costs for operational control purposes: that is, to promote cost control and efficiency.

The assignment of service department costs to production departments promotes cost control and efficiency by:

1. Providing incentives for efficient performance by the managers of the service departments
2. Motivating prudent use of the outputs from service departments by the managers of production departments

If the costs of using an internal service department are not assigned to user groups, a number of negative consequences can occur. First, more of the service may be demanded by user groups than it is economically reasonable to supply. Without incurring any charge for using a service department's resources, a user could attempt to use the service up to the point at which the marginal benefit is zero. Naturally, this would be well beyond the optimal usage, where the marginal benefit from the service equals the marginal cost of supplying it.

Second, without assigning the cost of the output from a service department, we cannot determine whether the service department is operating efficiently. In the absence of prices charged to profit-conscious departmental managers, the service department must be treated as a discretionary expense center. The budgeted costs, obtained from historical experience, may offer no guarantee that the department is operating efficiently. Also, no signals are available to determine the optimal scale or size of the service department. At times of financial stringency, the size of the service department may be contracted to reduce operating expense. This curtailment of activity may not be desirable if it restricts or downgrades the performance of production departments that would be willing to pay for additional amounts of the service.

Third, if a service department's output is not priced, little guidance exists on whether the firm should continue to supply the service internally. For many service activities, firms have the option to purchase the service externally. For example, utilities, data processing, maintenance, housekeeping, legal, industrial engineering, and security can be either supplied internally or purchased externally. Without a price system to compare relative costs, it may not be obvious when an internal service center is more expensive than external alternatives, because of either internal inefficiencies or an uneconomically small scale of operation.

Finally, if service department costs are not assigned to user departments, managers will have little guidance about the level of service to be provided or demanded. A service department may wish to avoid complaints from users and satisfy them by providing service of excellent quality, based on acquisition of sufficient resources to provide the best and most responsive service possible. If user departments were made to see the cost of receiving this level of service, they might opt for a more economical service level—functional, without frills, and less expensive. But without the incentives and signals emanating from costing the output of a service department, a user department has little opportunity to communicate its preferences on the cost versus service level dimension.

By assigning costs for the output of a service department, we can overcome these four difficulties. Managers of consuming departments who are assigned costs from service departments, based on the quantity and quality of services they receive, will:

1. Exercise more control over the consumption of that output in their departments
2. Compare the costs of using the internal service department with the costs of comparable services purchased outside the firm
3. Attempt to communicate to the service department the quality level of services desired, including showing their willingness to pay more to receive higher-quality service or to accept lower quality in order to pay less

Managers of service departments whose costs are transferred to user departments become aware that the cost assignment will be reviewed critically by profit-conscious departmental and divisional managers; hence, service department managers will be motivated to keep departmental costs down. They may become more entrepreneurial and innovative as they attempt to provide a level and quality of service that will be demanded by user departments. Thus, the service department managers become more responsive to the demands of user groups rather than offering service on a take-it-or-leave-it basis.

We have been focusing on the assignment of service department costs to control the demand and supply of the output from a service department. In principle, the prices could be determined by reference to potential outside suppliers of these services. This possibility will be discussed in Chapter 9 on transfer pricing. Using externally referenced prices would treat service departments as profit centers and, if carried to its logical conclusion, would allow revenue-producing centers the choice of acquiring the service either from the internal service department or from an outside supplier. Typically, however, the charges for use of internal service departments are based on the budgeted or actual costs of these departments, not on market-based prices. We will develop the methods for assigning the **costs** of service departments throughout this chapter. Consideration of a market-referenced pricing system will be deferred to the transfer price discussion in Chapter 9.

MEASURING COSTS OF USING SERVICE DEPARTMENTS

For cost control and efficiency considerations, service department costs should be *attributed* not allocated to operating departments. **Attribution** is the process of assigning a cost that is unambiguously associated with a particular cost object to that particular cost object. For example, consider the costs of a Power Department that a company maintains to generate its internal power needs. If some department of the company has special power needs, requiring expensive transformers and distribution equipment that are not used by

any other unit of the firm, then the costs of those transformers and distribution equipment can be attributed to that department.[3]

Even when an asset is not specifically designated to a particular production department, the output from that asset can still be attributed to operating departments. In this case, we need to choose a measure of activity to cost and charge for a service department's output. In the case of the Power Department, if each production department has a meter that records the consumption of electricity, then the cost of the output supplied by the Power Department can be unambiguously attributed to the production departments on the basis of metered usage. Other examples include the number of purchase orders filled for a purchasing department and hours of maintenance supplied for the labor component of a maintenance department. If a service department provides different kinds of services, then it must define a separate activity for each type of service so that the cost of using of each type of resource can be attributed on the basis of the demands for that resource category; for example, with a centralized computing resource, separate charges could be incurred for central processing unit hours, disk-memory storage, pages of output printed, and connect time.

AVOID ESTIMATES AND ALLOCATIONS FOR COST CONTROL

Costs that cannot be attributed directly are usually common to several departments and must be *allocated* to cost objects. **Allocation** is the process of assigning a resource cost to a department or a product when a direct measure does not exist for the quantity of the resource consumed by the department or product. Service department costs must be allocated when direct measurement of the output from a production department is not available. Allocation requires the use of surrogate not direct measures: for example, machine horsepower for charging utility expenses to unmetered departments, square footage occupied for housekeeping expenses, total direct costs for a controller's department, or direct-labor hours for many categories of factory overhead costs.

Direct measures may not exist for assigning the costs of these expenses because the cost of obtaining such measures, such as by metering individual production departments or by monitoring the amount of time the housekeeping staff spends in each department, greatly exceeds any potential benefit from using these direct measures. For example, in a site with a central power station and multiple plants on the site, an energy meter may exist only for each factory but not for individual departments within the factories. In this case, we cannot measure or control the usage of energy at the individual production department level. The costs of the central power station could be *allocated* to individual departments, using a surrogate allocation base such as the horsepower of machines within each department multiplied by estimated machine hours worked, but such a process is not valid for cost control or efficiency purposes. It would be like a bowling establishment that could measure only the total number of pins knocked down across all its lanes but not how many were knocked down at each individual lane. The proprietor could report the average number of pins knocked out at each lane, say 8.356, but this number would be of little significance for assessing the performance of individual bowlers.

The assignment of service department costs to producing departments for cost control and efficiency considerations requires an accurate measurement of the consumption of service department resources by each user department. Estimates and allocations can be useful for product costing and inventory valuation, but they are not useful when man-

agers are attempting to control carefully the production and use of a shared resource. Because the assigned cost will be based on a measure unrelated to the demands the production department made on the service department, the cost will not be the direct consequence of actions taken by the manager or workers in the production department. Therefore, the cost signal cannot provide useful feedback on operating performance in the production department during the period.

How might a manager respond to a cost signal based on an arbitrary allocation of costs? First, she might ignore the signal entirely, perhaps the optimal action, recognizing that the signal does not provide any useful information about actions taken in the recent past or likely to be taken in the near future. Two circumstances may prevent the manager from ignoring the signal entirely. First, managers are frequently requested to respond to variances in their periodic operating report and to reconcile the signal with other records, such as from the production control system. Thus, some amount of the manager's time must be committed to responding to reported cost variances, regardless of their source or accuracy.

Second, if the report will be considered when evaluating the manager's performance, the manager will naturally attempt to influence the signal that does get reported. Because the signal, by assumption, cannot be directly affected by the manager's actions in the production department, the manager can influence the signal only by arguing about and negotiating the allocation procedure with other managers, of both production and service departments, or the manager's superiors. These discussions clearly detract from the amount of time the manager has to improve efficiency, productivity, and quality within her own department. By allocating a cost that does not reflect resource consumption by a production department, but continuing to hold managers responsible for such a cost, the company has signaled that managers of such departments should spend some amount of their time discussing and negotiating about allocation percentages with other managers.

A FUNDAMENTAL COST ACCOUNTING EQUATION

A cost can be decomposed into a quantity and a price component. We can write a cost, C, as the product of a quantity, Q, of a resource multiplied by the unit price, P, of that resource:

$$C = P * Q$$

For example, utility expense can be represented as the product of kilowatt-hours (kWh) consumed (the Q measure) multiplied by the cost per kilowatt-hour (the P measure). When we referred to the existence of a direct measure on service department consumption, we meant that we have an accurate measure of the *quantity*, Q, of the service department's output (e.g., the number of kWh) consumed by a production department. Even with such a direct accurate quantity measure, the amount charged to a production department could still include estimates when the price measure, P, includes estimated or allocated costs. The price measure could include cost estimates from depreciation, floor space charges, and charges from other service departments.

We believe that the crucial issue, however, is not whether estimates are included in the price measure. More important is whether the quantity Q is measured directly or whether it is a rough estimate based on a surrogate measure. With a good measure of quantity consumed, the price measure would have to be substantially in error before it

would adversely affect managerial decisions. As long as operating managers are charged on the basis of an accurate quantity measure, they will probably not spend much time arguing about minor fluctuations in its unit price. Instead, they will act to use the quantity of the resource they consume efficiently and effectively.

If, however, the quantity Q is measured inaccurately, such as when costs of service departments are arbitrarily allocated to operating departments on the basis of headcount, floor space, or direct labor hours, then operating managers are not rewarded or punished for the quantity of the demands they place on service departments. In this case, the use of a surrogate, unrepresentative measure of Q has caused the cost signal to be ineffective in motivating operating efficiencies. Thus, cost attribution to operating departments can be performed when an accurate Q measure exists. But we create an undesirable, perhaps dysfunctional, cost allocation when we use an arbitrary measure for Q that does not represent the actual demands that an operating department makes on a service department.

In recognition of the arguments and distortions that arise when the output of a service department cannot be causally related to actions or demands of individual production departments, many companies divide their indirect and support departments into two categories: traceable and common. The expenses of the traceable service departments—such as maintenance, equipment supplies, setup, tooling, and energy—are assigned to production departments through either direct charging or using an assignment base (e.g., kWh, setup hours) that accurately represents the *quantity* of demands made by a production department on the service or support department. Thus, the expenses that are assigned to a production center include its own expenses (supervision, equipment depreciation and rental) plus directly traceable service and support expenses.

ASSIGNING SERVICE DEPARTMENT COSTS

Consider a utility department with the following cost characteristics. At its normal activity level of 170,000 kilowatt-hours per month, the utility department has a budget for total operating expenses (including materials and supplies) of $13,600. For fluctuations up to 25% on either side of the normal activity level, the variable cost of the utility department is $0.02/kWh. The utility department provides power to three operating departments, which have the following standard and actual demands for power:

	OPERATING DEPARTMENT			
	1	2	3	TOTAL
Practical capacity (kWh)	70,000	100,000	30,000	200,000
Normal activity (kWh)	60,000	85,000	25,000	170,000
Actual activity in January (kWh actually used)	60,000	50,000	27,000	137,000
Standard kWh allowed for output actually produced in January	55,000	50,000	28,000	133,000

During January, the utility department had actual operating expenses of $13,152.

At least three possibilities arise for assigning the monthly costs of the utility department to the three production departments.

1. Standard Average Cost ($0.08/kWh)

A standard rate system would start by calculating, at the start of the month, an energy rate of $0.08/kWh, obtained by dividing the utility department's budgeted expense of $13,600 by the normal output of 170,000 kWh. The expenses subsequently charged to the departments for the month would be based on the hours actually used by each department multiplied by the standard rate of $0.08:

	ACTUAL KWH	ASSIGNED POWER COSTS
Department 1	60,000	$ 4,800
Department 2	50,000	4,000
Department 3	27,000	2,160
Total	137,000	$10,960

In this situation, the use of a standard rate results in only 80% of the utility department's expenses being charged out to operating departments. Although some of this underabsorption could be due to inefficiencies in the utility department (as we will calculate soon), most of the underrecovery of cost has been caused by Department 2, which demanded 35,000 fewer kilowatt-hours than normal.

To estimate the impact on the utility department's expected costs of working so many fewer hours, we first need to estimate the three departments' monthly fixed cost component. The costs of the committed resources of the service department can be estimated as:

$$\text{Committed costs} = \$13{,}600 - [\$0.02 * (170{,}000)] = \$10{,}200$$

Therefore, at an actual volume level of 137,000 kWh, its expenses should have been:

$$\text{Flexible budget} = \$10{,}200 + [\$0.02 * (137{,}000)] = \$12{,}940$$

The difference between the expected costs ($12,940) that should be incurred at an activity level of 137,000 kWh and the costs charged to departments ($10,960) represents a **volume variance** (unfavorable) of $1980.[4] This volume variance could have been avoided either by working at the normal volume level of 170,000 kWh or, alternatively, if the decline in usage could have been forecasted soon enough, by resetting the overhead recovery rate to:

$$\text{Revised overhead rate } 5 \frac{\$12{,}940}{137{,}000} 5 \$0.09445/\text{kWh}$$

The remaining part of the utility department's variance between expected and actual costs for January is due to the utility department's not cutting expenses sufficiently given the

lower levels of demand during the period. Its actual expenses of $13,152 represents a spending variance of:

$$\text{Spending variance} = 13{,}152 - 12{,}940 = \$\ 212 \text{ (unfavorable)}$$

The sum of the volume and spending variance (1980 + 212) equals the $2192 total variance between actual expenses and the amount charged to operating departments:

$$\text{Total variance} = \$13{,}152 - 10{,}960 = \$2{,}192$$

The standard average cost approach has the advantage of having all production and service departments know in advance the costing rate for using the output from the service department. The rate is unaffected by volume fluctuations either in aggregate or by the individual operating departments. The disadvantages are that:

1. Not all the actual expenses are charged out to operating departments
2. It is not obvious how to assign responsibility for the volume variance of $1980
3. The service departments have little information on the short-run incremental cost of using more or less of the service department's output
4. The standard rate is affected by expected utilization of the resource; that is, if expected utilization is far below the capacity of the committed resources, the rate will be biased upward

2. *Actual Average Cost* ($0.096/kWh)

Some companies wait until they know the actual expenses and actual activity levels for the period. They calculate a rate by dividing the actual expense of the service department by its actual output. In this case, the actual rate for January would be $0.096/kWh ($13,152/137,000), and no variance analysis is required because actual expenses are completely assigned to operating departments:

	ACTUAL KWH	ASSIGNED POWER COSTS @ 0.096
Department 1	60,000	$ 5,760
Department 2	50,000	4,800
Department 3	27,000	2,592
Total	137,000	$13,152

Clearly, however, such a report would produce extensive argument and discussion among several of the operating department managers. First, Department 1 used exactly the hours forecasted for that department, yet the assigned power cost is $5760 rather than the expected (@ $0.08) charge of $4800. Second, Department 3, who worked 8% more hours than expected and therefore helped to consume some of the unused capacity, has a bill more than 20% higher than it would have anticipated. And Department 2, which had it worked at its normal 85,000 hours would have expected a power bill of $6800, actually sees about a 30% reduction in the costs assigned to it. So the department that caused the

higher rates for everyone else, because of a 40% reduction in utilization receives a lower bill, and the other two departments, operating at or slightly higher than their normal capacity see sharp increases in the expenses assigned to them. Department 3 has used more than the normal number of kilowatt-hours (which should produce a favorable variance because variable costs are well below full costs) and has actually used less than the standard number of kilowatt-hours for the output it produced; yet it shows an unfavorable variance on power costs.

The manager of Department 3 has been penalized for two factors not ordinarily under that manager's control:

1. The total amount of power consumed by the other two departments
2. The unit price and efficiency of the utility department

These two uncontrollable factors produce the unfavorable variance shown for Department 3. Note that if Department 2 had used its normal amount of 85,000 kWh instead of the 50,000 kWh it actually used, the cost per kilowatt-hour would have declined significantly for all departments. The fixed costs of the utility department would have been spread over many more actual hours of service. In effect, by working many fewer hours than normal, Department 2 has generated an unfavorable price variance for itself and an unfavorable total variance for the other two departments.

Also contributing to the unfavorable price variance are the inefficiencies in the utility department amounting to $212, as calculated in the previous section, which is being passed on to the operating departments through a higher average hourly rate. The present scheme charges a manager for the costs of activities and inefficiencies in departments over which the manager has little or no control. The operating departments are also being charged on an average, rather than on a marginal, cost basis. Thus, their managers might be turning down profitable opportunities they might have accepted had they known that incremental power cost them $0.02 to $0.03/kWh rather than the current budgeted figure of $0.08/kWh.

3. Flexible Budget for Short-Run Control of Operating Expenses

An improved system for attributing service department costs would have the following characteristics:

1. The level of activity and inefficiency in any single operating department should not affect the evaluation of other operating departments.
3. Efficiencies or inefficiencies in the service department should be reflected in the evaluation of the service department but not in the evaluation of any operating department.
3. The evaluation of the service department should not be affected by factors beyond its control, such as unanticipated fluctuations in the quantity of service demanded of it.
4. The operating departments should be encouraged to expand the use of the service department as long as the incremental benefits to them exceed the company's marginal cost of supplying the service.
5. The long-term costs of the service department should be paid by the users of its service. Usage of a service department to capacity under the pricing system can be viewed as a reliable signal to expand its capacity. If operating departments balk at paying long-run costs, the service activity can be contracted over time or perhaps made more efficient.

One relatively simple scheme achieves most, if not all, of these benefits. We consider a scheme in which:

1. Each department is charged for the actual quantities of service department output consumed but at a budgeted service department rate not at a rate computed on the basis of actual costs incurred in the service department.
2. Charges are separated into short-run fixed and short-run variable costs. Under this scheme, each operating department would be charged \$0.02/kWh actually used. The \$0.02 figure is the budgeted variable cost of the service department. Charging at this rate reflects the underlying cost driver (kWh) for the variable cost of the service department.
3. The cost of the committed resources (short-run fixed costs) are calculated on the basis of practical capacity of the resources not the expected utilization of the capacity in the forthcoming period.

The allocation of the \$10,200 committed costs to the three operating departments alerts the managers of these departments to the cost of supplying capacity in the power department. It is a reservation price to have access to the relatively low-cost (\$0.02/kWh) power on a variable-cost basis. It is also an estimate of the long-run component of marginal cost.

Long-run planning for the service department requires that its long-run costs be considered. For example, if we are estimating the future maintenance costs of a building about to be constructed, then we must consider the long-run maintenance costs. When considering a short-run decision, however, such as whether to undertake a particular maintenance job, we must consider the short-run costs and benefits of the maintenance. The key idea is that different costs are relevant depending on whether we are making a long-run or a short-run demand on maintenance services. These considerations motivated our recommendation that the fixed costs be assigned to production departments on the basis of planned use and that the variable costs in the pool be attributed to departments on the basis of the quantity of output actually used.

Two possibilities for assigning the committed-cost component are (1) proportional to practical capacity and (2) proportional to normal activity levels:

	DEPARTMENT			
	1	2	3	TOTAL
Practical capacity (kWh)	70,000	100,000	30,000	200,000
Percent of total	35%	50%	15%	100%
Assigned committed costs	\$3,570	\$5,100	\$1,530	\$10,200
Normal activity (kWh)	60,000	85,000	25,000	170,000
Percent of total	35.3%	50%	14.7%	100%
Assigned committed costs	\$3,600	\$5,100	\$1,500	\$10,200

In this example, little difference exists between the two assignment bases. In practice, however, we should use the base that most closely represents the demand for long-run ca-

pacity. This approach avoids the possibility of a death spiral (escalating rates) arising from short-term declines in expected utilization.

Under the proposed scheme, and assigning committed costs on the basis of practical capacity, the power department costs charged to the three operating departments in January would be:

Department 1	$ 3,570 +	60,000($0.02)	=	$ 4,770
Department 2	$ 5,100 +	50,000($0.02)	=	6,100
Department 3	$ 1,530 +	27,000($0.02)	=	2,070
Total	$10,200 +	137,000($0.02)	=	$12,940

The only variance recognized in the operating departments arises from using a nonstandard amount of power for the amount of output produced. In Department 1, 60,000 kWh were used instead of the standard allowance of 55,000 kWh. This difference generates an unfavorable usage variance of (5,000)(0.02) = $100. Department 3 shows a favorable usage variance of $20, because it used 1000 fewer kilowatt-hours than the standard allowance (1000 hours at $0.02 = $20). The utility department shows an unfavorable (U) spending (or efficiency) variance of

$$\text{Actual costs} - \text{budgeted costs at actual volume} = \$13{,}152 - \$12{,}940 = \$212\ (\text{U})$$

Note that this method eliminates the influence of rate fluctuations and usage by other departments from the evaluation of services consumed by an individual department. Each production department manager should understand that utility costs being charged to the department are the direct consequences of activities undertaken by and under the control of people in that department. The managers in each operating department will be motivated to use the output from the service department for applications in which the benefit exceeds the $0.02/kWh short-run variable cost. But the operating managers will still see the capacity or longer-run costs of operating the service department through the assigned committed costs. The manager of the service department will be evaluated on a flexible budget so that measured performance will not be affected by fluctuations in demand for the service from the service department. Any inefficiencies in the service department will be reflected in a spending variance for the service department and not passed on as higher charges to the operating departments.

By using standard costs that reflect expected performance, consuming departments have a guideline for short-run planning decisions, and service departments will absorb their own short-run production efficiencies or inefficiencies. If, however, the service department, through its continuous improvement programs, generated sustainable improvements in efficiency and productivity, the users of the outputs from the service department should see these cost shifts so that they can respond to the new cost structure. The implication is that the standard costs should be modified when actual service department costs are known to have shifted, especially when the resource—such as energy—may be critical to the strategic success of the firm.

SERVICE DEPARTMENTS NOT DIRECTLY SUPPORTING PRODUCTION OUTPUT

Organizations find that the costs of many service and support departments—such as scheduling, product engineering, plant administration, finance, information systems, human resources, purchasing, and materials handling—and plant-level expenses—including property taxes, building depreciation and insurance, and heat and light—cannot be directly assigned to production departments. There are two approaches for dealing with these difficult-to-assign expenses. One approach, unfortunately taken too often by too many companies, is to perform an arbitrary allocation process. The general support expenses are accumulated into a factorywide cost pool, perhaps called general factory overhead, and allocated to production departments using arbitrary measures such as:

- Direct labor hours
- Headcount
- Floor space

associated with each production cost center. We call such cost assignments arbitrary because the costs assigned to a production center may bear no causal relation to the demands by the department on the indirect and support resources. Therefore, decisions made by a production center manager, or employee, such as to reduce direct-labor hours or headcount (the resource drivers used in this arbitrary allocation process) cannot be traced back to a reduction in the demand for the indirect and support resources.

The second and much more preferable approach follows the discipline used to assign the more directly traceable costs to production departments. Each of the resources that are difficult to assign on the basis of the quantity of services demanded by production departments needs to be analyzed to (1) identify the activities performed by the resource and (2) determine the beneficiaries or recipients of the activities. As this process is followed, managers learn that two additional features must be added to the first stage, or resource assignment process:

1. Identify the primary activities, beyond conversion processes, performed for products by organizational resources.
2. Distinguish between primary and secondary activities.

We will discuss the role for activities not directly involved in conversion processes in Chapter 4, when we introduce activity-based cost systems. For the remainder of this chapter, we discuss the distinction between primary and secondary activities.

PRIMARY AND SECONDARY ACTIVITIES

The examples presented in this chapter have assumed that all activities performed by support departments directly benefited production cost centers. Many support or service departments in companies, however, do not directly support the production of products or delivery of services to customers. These departments provide support to other departments, many themselves service and support departments, as well as to production departments that directly benefit products. For example, consider a human resources or a payroll department that benefits people throughout the organization, in both production and sup-

port departments. Or consider the resources that provide space, heat, light, and air-conditioning throughout the plant, to both production areas and support areas. How do we assign these expenses, and do all these expenses eventually find their way to final products?

To illustrate how to handle this situation, let us assume that the Williams Company has two production departments, one primary support department, materials handling, that coordinates the receipt and disbursement of materials to production departments, and several other support departments including plant administration, factory support, security, buildings and grounds, information systems, and human resources. Analysis of the activities provided by these various support departments reveals three principal activities:

- Provide space: for people, machines, materials, and products.
- Provide CPU cycles of information processing.
- Provide employee support (training, advising, etc.).

The resource expenses from various support departments assigned to the activity Provide Space include building depreciation, insurance, taxes, heat, light, air-conditioning, security, internal housekeeping, and maintenance of surrounding grounds outside the factory. The output from this activity is square meters of usable floor space.[5] The cost of this activity would then be assigned to the space occupied by production departments (a primary activity), the space used by the materials handling activity (another primary activity), and the space used by the information systems (IS) equipment and people and the human resources department (secondary activities). After the cost of the Provide Space activity has been assigned, the costs of the IS and Human Resource (HR) departments will include not only their own traceable department costs but also the assignment of occupancy costs. The HR department costs—(associated with the activity Provide Employee Support—have as the cost driver the number of employees.[6] Because the IS department has a significant number of employees, it would receive a cost assignment from HR that would include its pro rata share of HR expenses, which would also include an occupancy charge for HR personnel that it received from the Provide Space activity. Thus two of the secondary activities, Provide Space and Provide Employee Support, would assign some of their expenses to primary departments and some to other secondary activities, such as Provide CPU Cycles. At the final round, the costs in the Provide CPU Cycle activity (which include space and HR costs) would be assigned to production departments and other primary activities on the basis of the number of CPU cycles used by each activity. So, eventually, the expenses of secondary activities will ripple through and find their way to production cost centers.[7]

THE NATURE AND PROBLEMS OF RECIPROCAL SERVICES

The next complication arises when reciprocal relationships exist among service departments. For example, a personnel department hires and oversees people for all departments in the organization; a utility department provides heat and light to all departments (including the personnel department and itself), a data processing department provides computer services and output to many service departments, a housekeeping department cleans all areas of a facility, and a maintenance department repairs machinery throughout a facility. With such interactions, an analysis that charges all the costs of each service department

directly to production departments and primary activities does not give an accurate picture of cost dependency.

We have already described how to attribute the costs of each service department to all departments, both production and service, that use its output. But once the process begins, just what *the costs* of a service department include is no longer clear. Besides its own traceable costs, each service department will start to accumulate charges from other service departments from which it receives services, and these must be reassigned back to its user departments.

Three major alternatives have been proposed to deal with this interacting, or reciprocal, service department situation:

1. The direct method, in which all service department costs are assigned only to production or primary activities, and the use of service department costs by other service departments and their secondary activities are ignored.
2. The step method, which has the potential of only partially considering the reciprocal services. The step method was illustrated in the preceding section when first the space costs were assigned to human resources and information systems, and then the HR costs were assigned to IS. In this process, we ignored the reciprocal, or feedback, relationship between the secondary activities. For example, we ignored the assignment of IS costs to the HR and Provide Space activities and the assignment of HR costs to the people who participated in the Provide Space activity.
3. The reciprocal method, which models any reciprocal services exactly.

Until the mid-1970s, the direct method was virtually the only method known and used in practice. This situation changed when the Cost Accounting Standards Board (CASB) proposed that the reciprocal method be used instead of the direct method. The proposal instantly legitimized the reciprocal method as the preferred method. Subsequently, the CASB relented when companies complained that they had neither the expertise nor the computing capability to implement the reciprocal method.[8] The CASB then adopted the step method as an acceptable alternative to the preferred reciprocal method and indicated that the direct method was permissible only if it produced costs that approximated those produced by the step method.

During the period when they were reimbursed on the basis of costs incurred, hospitals had elaborate procedures for allocating their support department costs to units that delivered services directly to patients, such as in-patient care, operating rooms, recovery rooms, pharmacy, radiology, and pathology. The traditional step method for allocating support department costs began to be supplanted by the reciprocal method when computing resources became more available to health-care providers. Because the direct and step-down methods are straightforward and illustrated in most introductory textbooks, we will deal only with the reciprocal method, using the Fall River Company as an example.

Fall River Company: A Numerical Example

The Fall River Company is organized into four units: Power, Water, Division 1, and Division 2. The Power Department supplies power, generated by steam, to the four units using its equipment and consumes water supplied by the Water Department. The Water Department supplies water to the four units from a private reservoir and its water purification equipment. Division 1 and Division 2 are engaged in the primary manufacturing opera-

tions of the firm. The firm's management has dictated that all service department costs must be distributed to the two production divisions.

During the past year, the activities of the two service departments (Power and Water) were as follows:

		UNITS OF SERVICE PROVIDED TO				
		POWER	WATER	DIV. 1	DIV. 2	TOTAL
Units of service provided from	Power	20,000	30,000	80,000	70,000	200,000
	Water	70,000	10,000	30,000	50,000	160,000

The traceable costs are $3,000,000 in the Power Department and $1,600,000 in the Water Department.

The reciprocal method of cost assignment operates in two steps. The first step considers all service department interactions and computes a charge rate for each service department. In the second step, the charge rate computed in the first step assigns the costs of the service department to each user in proportion to the service levels provided to that user.

The initial objective in the reciprocal method of cost attribution, then, is to find a charge rate for the service departments such that the total charges out of each service department equal the total charges incurred by, and assigned to, each department. In this problem, the required rates are $22.57 for the Power Department and $15.18 for the Water Department. (The details of the calculations are provided in Appendix 3.1.) Exhibit 3.2 demonstrates that these rates have the property of clearing the internal accounts.

The method of finding the charge rates for the two service departments involves constructing a system of simultaneous equations to represent the interactions between the departments and solving the equations to find the appropriate charge rates. The total cost

EXHIBIT 3-2 Fall River Company—Service Department Cost Assignment: Reciprocal Cost Method

	POWER	WATER	DIV. 1	DIV. 2
Initial cost	$3,000,000	$1,600,000	N/A	N/A
Assigned by power*	451,400	677,100	$1,805,600	$1,580,000
Assigned by water*	1,062,700	151,800	455,400	759,000
Assigned out†	−4,514,100	−2,428,900	0	0
Net cost assigned	0	0	$2,261,000	$2,339,000

**Total service units consumed (the quantity measure) multiplied by the charge rate per unit.*
†Total service units provided (the quantity measure) multiplied by the charge rate per unit.

to be assigned from the Power Department (called the Power Department's reciprocal cost, PDRC) is computed as

$$\text{PDRC} = \text{initial cost incurred} + (20{,}000/200{,}000) * \text{PDRC} + (70{,}000/160{,}000) * \text{WDRC}$$

where WDRC is the Water Department's reciprocal cost. Note that the reciprocal cost is computed by adding, to the initial cost incurred in the service department, amounts that reflect the Power Department's share of the reciprocal cost of all the service departments including its own.

The above equation cannot be solved because it contains two unknown variables, PDRC and WDRC. A second, and comparable, equation in the two unknown variables can be written for WDRC:

$$\text{WDRC} = \text{initial cost incurred} + (30{,}000/200{,}000) * \text{PDRC} + (10{,}000/160{,}000) * \text{WDRC}$$

In general, we would construct one reciprocal cost equation for each service department. The formulas can be simplified to:

$$\begin{aligned} (0.9) * \text{PDRC} - (7/16) * \text{WDRC} &= 3{,}000{,}000 \\ -(3/20) * \text{PDRC} + (15/16) * \text{WDRC} &= 1{,}600{,}000 \end{aligned}$$

When these equations are solved, the reciprocal costs and the indicated charge rates can be computed. Fortunately, computer programs in common spreadsheet languages can solve large systems of simultaneous linear equations so that we do not have to do the calculations by hand.

The Economic Insights of the Reciprocal Method

So far, we have developed what seems to be just another approach for assigning service department costs to production departments. What remain to be shown are the valuable properties of the reciprocal cost method.

It turns out that the charge rate per unit of service computed by the reciprocal method actually represents the cost of supplying the service to production departments and other service units. In our numerical example, assume initially that all the costs are variable with demand. If the total demand by the production divisions on the Power Department were reduced by one unit, the total costs in the system would fall by $22.57. This charge rate, therefore, represents the marginal cost of providing the service. It provides a reasonable benchmark for comparison with an outside quoted price. Specifically, if an outside utility offered to provide power at the rate of $21 per service unit, the bid could be accepted (because it is less than the inside cost of $22.57 per service unit).[9]

In general, neither the step-down method nor the direct method will compute sufficiently accurate service department costs when extensive interactions exist among service departments. The accuracy and relevance of the reciprocal method derive from its recognition of the reciprocal relationship of costs among service departments. Because the Power Department uses such a large part of the output of the Water Department, the cost of supplying an additional unit of power must reflect not only the direct costs incurred in the Power Department but also the indirect costs incurred in the Water Department.

The Treatment of Committed Costs

We assumed, initially, that all costs were short-term variable. With the basic model in place, we can now abandon that assumption. But first we must develop two more insights from the information provided by the reciprocal method.

As we argued above, the primary reason for assigning variable and fixed costs separately arises from their different causal factors, or cost drivers. The cost driver for the flexible resources is short-run usage, whereas the cost driver for the committed resources is planned long-run usage. Therefore, to assign service department costs, we require a dual-rate system: one rate for the (variable) costs of flexible resources and one rate for the (fixed) costs of the committed resources. Because variable costs are directly attributable to the user demanding the service, it is economically sound and equitable (if that is a consideration) to attribute variable costs on the basis of the actual quantity consumed.

We assign, as described earlier in the chapter, the costs of the committed resources in proportion to the planned use of capacity they supply. If one division reserves 20% of the output of a facility, then that division should be assigned 20% of the committed costs of the facility. This principle is consistent with activity-based costing (as will be presented subsequently) and with economic arguments (not presented here).[10] This approach, called peak-load pricing, asks users to bear the system costs in proportion to their use of the facility when it is operating at capacity. It has been widely used in utility regulation in North America and Europe.

Thus, even interacting service department costs can be assigned by the approach described in this chapter. The costs of flexible resources in the service department will be assigned on the basis of actual usage, and the cost of committed resources will be assigned on the basis of planned usage.

Make-or-Buy Decisions and Cost Assignments

If a service department in a reciprocal services situation is shut down, the number of service units purchased externally will be lower than the current production of the internal service department. When the units of service are purchased outside, the current reciprocal pattern of consumption is altered, because the remaining departments do not have to provide service to the external supplier. In the illustration, the Power Department currently supplies power to the Water Department and consumes water provided by the Water Department. Indirectly, then, the Power Department is consuming some of its own output.

The reciprocal method provides information about the number of outside units of a service that would have to be purchased if internal production were discontinued. In this example, if the firm discontinued internal production of power, 166,000 units of power would have to be purchased externally. If water production were discontinued, the firm would have to purchase 138,333 units externally. (Details of these calculations can be found in Appendix 3.1.) We can see, then, that the Power Department consumes 34,000 (200,000 − 166,000) units of its own output. If the power were purchased outside, this indirect consumption would be eliminated.

Another piece of information provided by the reciprocal method is a reciprocal factor for each service department. In this example, the reciprocal factor for the Power Department is 1.2048, and the reciprocal factor for the Water Department is 1.1566. The

reciprocal factor for a service department tells us how much the total production of the service department will fall if the external demand on the service department is reduced by one unit.

With the knowledge of the outside units required and the reciprocal factor, we can now evaluate the make-or-buy decision. Kaplan[12] showed that the total variable cost avoided when a service department is shut down can be computed as

$$\text{Variable cost avoided} = \frac{\text{reciprocal cost for the department}}{\text{reciprocal factor for the department}}$$

If we apply this rule to the example, the variable cost avoided if the Power Department is shut down is $3,746,680.[13]

Next we must consider the fixed cost saved if the department is shut down. Suppose the power-generating facilities can be sold, and fixed costs of $2,000,000 are thereby avoided. The total of all costs avoided would be $5,746,680 (3,746,680 + 2,000,000).

Finally, we can compute the maximum price that we would pay to an external supplier. The external number of units required is 166,000, so the maximum price the firm would be willing to pay, per unit provided, to an external supplier is $34.62.[14]

SPECIAL CASE FOR ARBITRARY ALLOCATIONS

This entire chapter has focused on analytic, causal methods for assigning indirect resource expenses to production departments. We have argued against arbitrary cost allocations that bear little relation between the consumption and supply of resources. One exception to this rule can be noted. Seemingly arbitrary cost allocations may be useful to force periodic managerial discussions and negotiations. For example, some corporations deliberately allocate all corporate overhead expenses to operating departments with allocation bases (such as sales dollars, headcount, or total costs) that have little to do with the consumption or causes of the overhead costs. Senior managers apparently want operating managers to be aware of centrally determined and controlled costs. Perhaps the fully allocated costs are meant to encourage more-aggressive pricing decisions by the decentralized managers (which may or may not be a good idea). But they may also serve to enlist operating managers' support in curtailing the growth of corporate expenses. Only by having all responsible managers see the costs of company planes, corporate headquarters' buildings and furnishings, and other such discretionary expenses may countervailing forces be set in motion to limit the growth and escalation of the costs.

For example, one study[15] examined why a high-tech company (1) assigned marketing expenses and revenues to the managers of product development departments and also (2) assigned product development expenses to marketing managers. The product development managers had no marketing authority and the marketing managers had no product development authority; yet each was held responsible for the actions of the other in a seemingly arbitrary exercise in allocating noncontrollable costs and revenues. The plausible and defensible rationale for this practice was to force active and continual dialogue among product development and marketing managers on the needs of the marketplace and the marketability of proposed products. In this case, the discussions and negotiations

that accompanied the arbitrary allocation of costs and revenues were exactly the actions that the senior management of the company wanted to encourage.

To summarize, if we want operating managers to promote efficiencies, improve productivity, and learn more about the characteristics of production processes under their control, then we should send them accurate measures of quantities and good estimates of costs of input resources consumed. If such accurate measures do not exist, then arbitrary quantity measures should not be substituted. Doing so would, in effect, transform a desirable cost attribution into an undesirable cost allocation.

If, however, we want managers to spend much of their time away from their areas of direct responsibility and authority, in discussions and negotiations with other managers about each other's actions, then arbitrary allocations will motivate that behavior. A useful compromise between these conflicting objectives can perhaps be made. Any arbitrary allocation of costs should be done infrequently, say annually, to signal the need for occasional outside discussions and negotiations. Or, alternatively, the company can report to each operating department the total periodic cost of any common or joint corporate resource, without assigning, as the responsibility of individual operating department managers, arbitrarily carved-up pieces of these common or joint costs. The regular periodic operating reports, however, should be left relatively uncontaminated from data that do not accurately reflect actual resource consumption by operating units.

SUMMARY

Assigning the costs of service departments to production departments sets up an internal market for the supply and demand of internally produced services. By charging for service departments' output, we can:

- Ration demand from user departments
- Provide signals on service department efficiency
- Facilitate comparison with externally supplied service
- Provide opportunities for price-quality tradeoffs

When charges for service department costs are determined, a user department's charges should not be affected by activity levels in other user departments or by inefficiencies in the service department. Also, fluctuations in demand by user departments should be charged on a marginal-cost basis. We have proposed the following scheme:

1. Assign any of the costs of a service department that are directly attributable to a specific organization unit to that unit.
2. Assign the remaining costs in the service department to cost pools based on the factor (the cost driver or quantity measure, as we have referred to it here) that causes each cost to vary in that pool. This approach results in the segregation of costs both by function and by whether they are fixed or variable.
3. Assign the costs in each cost pool to other organization units on the basis of accurate quantity measures of each organization unit's use, or consumption, of the cost driver.

When budgeted rather than actual costs are used to assign service department costs, cost shifts or inefficiencies will be isolated within the service department and not passed on to production departments.

A special problem arises when service departments provide service to each other as well as to production departments. In this case, the costs of the interacting service departments can be assigned using a simultaneous-equation technique (the reciprocal method). The reciprocal method is essential if we want an accurate estimate of the marginal cost of internally supplied service or when attempting to decide whether to replace an internal service department by purchasing the service externally.

APPENDIX 3.1: THE RECIPROCAL COST PROCEDURE

This appendix provides the algebraic basis for the reciprocal service department assignment procedure described in the chapter. Begin by observing that the reciprocal process can be represented by a system of simultaneous equations defining the reciprocal costs. The equations for the problem discussed in the chapter are repeated here:

$$[(0.9) * \text{PDRC}] - [(7/16) * \text{WDRC}] = 3{,}000{,}000$$
$$[-(3/20) * \text{PDRC}] + [(15/16) * \text{WDRC}] = 1{,}600{,}000$$

These equations can be expressed in algebraic terms as

$$[I - A][B] = [C]$$

where the items in brackets represent matrices or vectors. Thus, in this case:

$$[A] = \begin{bmatrix} 2/20 & 7/16 \\ 3/20 & 1/16 \end{bmatrix} \quad [I] = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \quad [B] = \begin{bmatrix} \text{PDRC} \\ \text{WDRC} \end{bmatrix}$$

$$[C] = \begin{bmatrix} 3{,}000{,}000 \\ 1{,}600{,}000 \end{bmatrix}$$

The $[A]$ matrix indicates the usage proportions. The element in the ith row and jth column of this matrix represents the fraction of the total output of service department j consumed by service department i. The $[I]$ matrix is an identity matrix. The $[B]$ vector is the vector of reciprocal costs. The $[C]$ vector is the vector of variable costs initially recorded in each of the service divisions. We can solve for matrix $[B]$ by observing that

$$[B] = [I - A]^{-1}[C]$$

where $[I - A]^{-1}$ is the inverse of matrix $[I - A]$, if one exists. This point, incidentally, is where the computer is useful. Functions that compute inverses are provided in most spreadsheet programs. In the case of the example in the chapter:

$$[I - A]^{-1} = \begin{bmatrix} 1.2048 & 0.5623 \\ 0.1928 & 1.1566 \end{bmatrix}$$

and

$$[B] = \begin{bmatrix} 4{,}514{,}056 \\ 2{,}428{,}915 \end{bmatrix}$$

The numbers on the main diagonal (the line running from the upper left to the lower right) of the $[I - A]^{-1}$ matrix provide the reciprocal factors that are useful for decision making. There is, by construction, one reciprocal factor on the main diagonal for each of the service departments. In the case of our example, the first factor, 1.2048, is related to the Power Department, and the second factor, 1.1566, is related to the Water Department. These are the reciprocal factors.

Dividing the reciprocal (variable) cost of a service department by its associated reciprocal factor yields the cost avoided if that department is shut down. Moreover, dividing the number of units of service currently provided by a service department by the department's reciprocal factor yields the number of units required if the service is acquired externally. The charge rate per unit of service provided by the service department is given by dividing the department's reciprocal cost by the number of units of service provided. Thus, the charge rate for the Power Department equals 4,514,056/200,000 = $22.57.

As we have seen in the example, the cost to be assigned to the production division equals the product of the service department's charge rate and the number of units of service provided to the division. The indicated assignment can also be obtained by extending the algebraic model developed above. Define a matrix $[D]$ such that the element in the ith row and the jth column represents the fraction of the total output of service department i consumed by production division j. Then $[E]$, the vector of service department costs to be assigned to the production divisions, is given by

$$[E] = [B]^T [D]$$

where $[B]^T$ is the transpose of the vector of the reciprocal costs.

In the case of the example:

$$[B]^T = [4{,}514{,}056 \quad 2{,}428{,}915]$$

$$[D] = \begin{bmatrix} 80{,}000/200{,}000 & 70{,}000/200{,}000 \\ 30{,}000/160{,}000 & 50{,}000/160{,}000 \end{bmatrix}$$

$$[E] = [2{,}261{,}044 \quad 2{,}338{,}956]$$

This means that a total of $2,261,044 of the service department costs is assigned to Division 1, and $2,338,956 is assigned to Division 2.

The analysis can easily be extended to any number of service and production departments.

ENDNOTES

1. As in Chapter 1, we use the term *products* to refer to all cost objects, which include tangible products (a box of cereal) but also services (a checking account) and customers.
2. R. S. Kaplan, "One Cost System Isn't Enough," *Harvard Business Review* (January–February 1988), pp. 61–66; also, "The Four Stage Model of Cost System Design," *Management Accounting* (February 1990).
3. And, to anticipate concepts that we will discuss in Chapter 10, not only the operating expenses of the assets but also the value of the assets themselves may be assigned to operating departments.
4. We will defer to the problem material at the end of the chapter the alternatives available for assigning this aggregate volume variance back to the individual operating departments.

5. In many factories, not all space is equally costly to supply. For example, in semiconductor wafer fabrication facilities the expense to provide cleanroom space is much higher than the expense to provide normal space. In such cases, the analyst should have at least two activities: Provide Normal Space and Provide Cleanroom Space. The Provide Cleanroom Space activity would incur much higher utility expenses because of the need to recirculate and filter air continuously. Similarly, space provided for warehousing raw materials and finished goods may be less expensive to supply and support than the temperature- and humidity-controlled space required for sophisticated electronics-controlled equipment.
6. Again, this treatment assumes that all employees demand the same time and other resources from the HR department. It would be more realistic, but more complicated, to allow for the HR activities to be more focused on some employees than on others. One could either construct a weighted HR service index to represent the complexity of demands by different individuals, or one could split what is now a homogeneous activity, Provide Employee Support, into two or more separate categories—Provide Complex Support, Provide Average Support, and Provide Basic Support—with employees associated with one of these three mutually exclusive activities.
7. Exactly the same procedure can and should be performed in the activity-based cost (ABC) systems, to be described in Chapter 4. With ABC systems, instead of tracing the costs of support activities just to production cost centers, the costs of support departments will be assigned as well to primary activities, those that directly benefit the production and sales of products.
8. Today, such capability is readily available on common spreadsheet programs running on personal computers.
9. Before outsourcing the power generation to such an outside bidder, the company might first see whether its internal service department can implement process improvements to lower the costs of supplying power below that of the external supplier. Also, the company should check that the quoted price is not artificially low—designed to get the business initially but subsequently to be raised once the company has dismantled its internal power generation department.
10. See, for example W. J. Baumol, "Optimal Depreciation Policy: Pricing the Products of Durable Assets." *Bell Journal of Economics and Management Science* (Autumn 1971), pp. 638–56.
11. R. S. Kaplan, "Variable and Self-Service Costs in Reciprocal Allocation Models," *Accounting Review* (October 1973), pp. 738–48.
12. (4,514,000/1.2048).
13. (5,746,680/166,000).
14. J. Dent, "Tension in the Design of Formal Control Systems: A Field Study in a Computer Company," in *Accounting & Management: Field Study Perspectives*, ed. W. J. Bruns Jr. and R. S. Kaplan (Boston: Harvard Business School Press, 1987), pp. 119–45.

■ *PROBLEMS*

3-1 Allocating Central Service Department Costs

"I can't believe it. We just went through a study showing how my department could save money by using the central maintenance department. But the first month using this department shows that my costs are up more than 20 percent." Don Thompson, the general manager of the Delta Division of Ramo Products, had just received his monthly bill for maintenance services and he was obviously upset.

TABLE 1

DIVISION	MAINTENANCE HOURS	PERCENTAGE	ASSIGNED COSTS
Able	600	50%	$ 60,000
Baker	400	33%	40,000
Carter	200	17%	20,000
Total	1,200	100%	$120,000

TABLE 2

DIVISION	MAINTENANCE HOURS	PERCENTAGE	ASSIGNED COSTS
Able	600	42.9%	$ 55,700
Baker	400	28.6%	37,100
Carter	200	14.3%	18,600
Delta	200	14.3%	18,600
Total	1,400	100%	$130,000

Before converting to the in-house department, the Delta Division had used outside suppliers for its maintenance services, at a cost of $15,000 per month. An internal task force, investigating the use of outside services that were also available internally, had found that all the maintenance needs of the Delta Division could be handled internally. At present, the maintenance department had unused capacity, and the additional services required by Delta could be supplied at an incremental cost of $10,000. After some assurance that his division's maintenance services could be supplied at this lower incremental cost, Don Thompson agreed to convert from external to internal supply of services.

After receiving a monthly bill for more than $18,000 for maintenance, Thompson demanded an explanation. Phil Johnson, the manager of the maintenance department, provided the following data. Table 1 shows the allocation of the monthly maintenance department costs of $120,000 to the three other divisions of Ramo Products, before handling Delta's requirements: As Johnson explained, "We have to charge out the costs of our division in some equitable manner. We've decided that an allocation based on hours supplied is as good as any." Johnson then showed (see Table 2) how the allocation to Delta was derived on the basis of incremental costs of $10,000 and the 200 maintenance hours provided to Delta.

Required

(1) Comment on the method used by Johnson to charge for the use of maintenance in Ramo Products. Why does this method cause Delta's charges to increase from $15,000 to $18,600 per month?

(2) Suggest alternative methods for charging for the use of this internal service department that would provide better incentives for use of this department.

3-2 *Allocating Service Department Costs—Fixed and Variable; Actual and Budgeted*

"I get overcharged by the Printing Department each month," declared Bud Perles, the manager of the Greene Company's Advertising Department. "Even though my usage is down during the month, the total amount I have to pay keeps going up. The work done by our Printing Department is certainly high quality, but if these charges keep escalating, I'm going to start taking my business to outside printers."

The Printing Department of the Greene Company provides services to many departments throughout the company. The cost budget for the Printing Department at a normal volume of 800 service hours as well as the actual expenses for September (when 700 hours were actually used) appear below:

	BUDGET AT 800 HOURS		
	AMOUNT	FIXED (F) OR VARIABLE (V)	ACTUAL IN SEPTEMBER
Labor	$10,000	V	$ 9,000
Supervision	2,000	F	2,000
Indirect labor	3,000	V	2,800
Supplies	11,000	V	10,500
Depreciation	6,000	F	6,200
Rent	4,000	F	4,500
Total	$36,000		$35,000

Depreciation charged each month is a fixed percentage of the original cost of equipment installed in the Printing Department. The rental charge is an allocated share of total monthly building costs. The allocation is proportional to the space occupied by each department.

The cost of the Printing Department is charged to other users on the basis of average *actual* departmental costs during the month multiplied by the number of printing hours used during the month.

The Advertising Department of the Greene Company is a heavy user of the Printing Department's services. Normally, the Advertising Department uses 100 hours each month from the Printing Department, but during September it used 95 hours. The quote at the beginning of the problem was made when Bud Perles received his bill for September usage from the Printing Department.

Required

(1) Compute the budgeted charge to the Advertising Department at normal volume. Also compute what the budgeted charge would be if the Advertising Department used 95 hours in a month (assume that total demand for the Printing Department remains constant at the budgeted 800 hours).

(2) Compute the actual charge from the Printing Department to the Advertising Department during September.
(3) Analyze the difference between what Advertising might have expected to pay at its normal volume of 100 hours and what it actually had to pay for the 95 hours it used during September. Indicate who is responsible for various differences between budgeted and actual costs.
(4) Comment on any changes you would recommend in charging for the Printing Department.
(5) Alice Deming, the manager of the Printing Department, responds to Perles's criticism: "We do the best we can in controlling our costs, but it has been difficult because the number of hours we've been working has decreased over the past several years. At the same time, however, we've had to acquire more expensive and sophisticated printing equipment to handle the requests being made by the Advertising Department. That department has been a heavy user of these machines, which the other departments in the company hardly use. If anything, we should charge the Advertising Department more for our services." How did this situation develop, and should a change in the pricing method for the Printing Department's services be made in light of this new information?

3-3 *Allocating Fixed Costs of Central Facility*

Belmont Hill Distributors is a decentralized firm specializing in the distribution of consumer products. The firm is divided into three operating divisions along the major product lines: Tru-Fit Hardware Supplies, Mudd Beauty Products, and Atomo Lighting Fixtures.

Three years ago, the company acquired a huge, highly automated regional warehouse. This effort was undertaken as a company project, since no single division had the size to take advantage of the economies of scale attainable by using such a warehouse. At the time of purchase, the three divisions agreed to "share costs on the basis of usage."

The past three years have witnessed large changes in the divisions. Tru-Fit Hardware Division has nearly doubled its volume of operations, whereas the Atomo Lighting Fixtures Division has suffered serious sales setbacks.

Against this background, a meeting took place between the corporate controller and the three divisional controllers. The meeting had been requested by the controller, Art Green, of the Tru-Fit Hardware Division, who was upset about the rapidly increasing warehouse costs being allocated to his division. Green commented: "This business of allocating total warehouse costs to divisions on the basis of actual usage has been prejudicial to our division." Further, Green proposed that "in the future, fixed costs (capital costs) be allocated on the basis of planned usage and *standard* variable cost on the basis of actual usage." Ralph White, the Atomo controller objected, saying, "What if our usage continues to fall? We will end up subsidizing the capital charges associated with the facilities that Tru-Fit uses."

Required

(1) Comment on this controversy. Do you believe that White's point is valid? If not, why? If so, what would you do to resolve this impasse?
(2) Assume that all the facts are the same as before with one exception. In this case, the above discussion ends with the following comment from Reg Brown, controller of the Mudd Division: "I'm sick of having to fight about these unreasonable cost allocations all the time. There is an organized market for warehouse space out there that would cost us less than what we pay now. We are taking our business outside."

How, if at all, would this proposal alter your response?

3-4 *Fort Erie Consumer Products*

Fort Erie Consumer Products manufactured a wide range of consumer products. To support all aspects of its acquisition, manufacturing, distribution, and marketing operations, the company maintained a graphics department. This department, called the Corporate Graphics Department, employed graphics designers and maintained and operated its own printing equipment.

The company was organized on a responsibility basis. The method of evaluating the various responsibility centers varied. Some of the centers were evaluated as cost centers, others as profit centers, and still others as investment centers.

When the Corporate Graphics Department was first established in 1994, there was relatively little interest in, or demand for, the products of the department. To encourage the use of these graphics capabilities, management decided not to charge the services and products of the graphics department to users. By mid-1995, the Corporate Graphics Department was running at capacity and was issuing requests to buy more sophisticated (and very expensive) printing equipment. There was some concern that the graphics department was empire building in the sense that it was acquiring equipment that was technologically elite but had no obvious or legitimate use in the firm.

To provide some control over the Corporate Graphics Department, Maureen Jackson, the vice president of finance, decreed in early 1996 that the Corporate Graphics Department would be run as a cost center. That is, Martin Roy, the manager of the Corporate Graphics Department, would be evaluated on the basis of his ability to control the department's costs relative to budgeted, or standard, costs for the work done. Moreover, to exercise some control on the empire-building inclinations of the graphics department, she declared that the department would be required to charge out all its costs to users. That is, the graphics department was to become customer-driven in the sense that it could not incur any costs that would not be reimbursed by customers.

In response to the vice president's decision, Martin developed a charge rate for his department. Martin decided that there were two classes of costs in his department: materials costs and overhead costs (which consisted of all the costs other than materials costs in the Corporate Graphics Department). In 1995, the graphics department had undertaken 12,736 jobs and had incurred materials costs of $6,704,948 and overhead costs of $5,678,346. There were many components of overhead costs, but the primary components of overhead costs were equipment and equipment-related costs of $3,586,239 and salary costs of $1,408,376.

The decision was made that the charge for any job would be the out-of-pocket materials costs for doing the job, plus an allocation to cover the overhead cost. The materials cost for any job was readily available from the job-cost sheet maintained for each job. The overhead rate for each job was computed by taking the overhead cost per job in the preceding year and adding 10%. Therefore, this rate in 1996 would be $490.44 per job. Martin provided the following rationale for his decision:

> This method is simple and easy to implement. It requires that each job absorb its own materials costs plus bear its fair share of the overhead of the Corporate Graphics Department. The 10% uplift of costs is needed to cover the installation and breaking-in costs of the new equipment that is not yet operational that we feel we ought to

> continually acquire in order to provide a full range of printing capabilities. We think of these costs as the research and development costs that we have to incur so that we can educate ourselves and our customers about how to use the state-of-the-art equipment that we are buying.

In 1996, for the first year since the Corporate Graphics Department had been created, demand for jobs fell off. In an attempt to discover what had happened, Maureen Jackson commissioned a special study of users. Although there were many complaints—including dissatisfaction with the timeliness of the work done, the quality of the work done, and the willingness of the Corporate Graphics Department to listen to and meet the customers' needs—the major complaint was cost. The following comment from Paul Tremaine, the manager of the Safety Department, summarized many of the criticisms:

> I'm tired of dealing with these guys. They spend all their time trying to talk us into using their fancy equipment. They have about twelve pieces of printing equipment in there, most of which are doing things that we will never need. We have specific needs, dictated by employee safety standards and requirements, for graphics materials. I do not need graphics consultants and fancy offset printing. I need visibility and coverage provided economically. We know what we want; we just cannot print it ourselves. And their prices—well, they are way out of line. I have a specific budget for printing safety posters and I am going to take my business outside. I can get the same job done outside for about half the cost that I am expected to pay internally.

On the other hand, the comments of some users were very positive. The director of new promotions in the Marketing Department made the following comments:

> I think that their service is great. Their graphics consultants are great—creative and innovative. They take their time and provide outstanding artwork and high-quality graphics. And the cost is next to nothing; we would have to pay almost ten times as much for the same service outside.

In response to these comments, in early 1997 Maureen Jackson directed one of her staff consultants to undertake a preliminary analysis of the situation and provide some alternative approaches to dealing with the problems identified. The gist of the consultant's report was that the cost allocations did not reflect the actual demands and usage of the Corporate Graphics Department. Moreover, the consultant pointed out that conventional cost accounting wisdom required that fixed costs and variable costs be charged and allocated separately. Variable costs should be allocated on the basis of actual usage, and fixed costs on the basis of planned usage. The consultant pointed out that, under the current scheme, materials costs were allocated on the basis of actual cost, whereas fixed and variable overhead costs were allocated on the basis of actual usage. That approach, the consultant pointed out, might create problems.

Required

(1) What benefits might accrue from allocating fixed costs on the basis of planned usage and variable costs on the basis of actual usage?

(2) Should standard or actual costs be allocated in a charge-out system such as this?
(3) Explain why the scheme developed by Martin Roy does not fulfill Maureen Jackson's intention that the cost-charging scheme should control the Corporate Graphic Department's empire-building tendencies. What evidence is there of the failure to meet that objective?
(4) What would you recommend to provide the Corporate Graphics Department with a more effective motivation to operate effectively and efficiently?

3-5 *Reciprocal Cost Allocations*

Arlington Acoustics manufactures a line of quality speakers. The main production departments are Shipping, Assembly, and Fabrication. These departments are provided with services from centrally maintained facilities: computer; heating and air-conditioning, and power.

The company is organized on a profit-center basis, with the service departments treated as cost centers. Consequently, each period, the costs of computing, heating, and power must be allocated to the production departments.

The company follows the practice of allocating budgeted fixed costs on the basis of planned usage and standard variable costs on the basis of actual usage.

The distribution of actual units of service provided last week is:

	COMPUTER	HEATING	POWER	SHIPPING	ASSEMBLY	FABRICATION	TOTAL UNITS
Computer	500	1,000	2,000	2,000	2,500	2,000	10,000
Heating	3,000	2,000	4,000	5,000	3,000	3,000	20,000
Power	750	750	250	750	1,000	1,500	5,000

These service levels corresponded to the amount of planned usage. This week's costs were as follows:

	STANDARD VARIABLE COST	BUDGETED FIXED COST
Computer	$30,000	$ 50,000
Heating	$60,000	$100,000
Power	$40,000	$ 80,000

Required

(1) Allocate the fixed and variable costs using the reciprocal allocation method.
(2) What is the variable cost per unit of service provided by the computer facility?
(3) Suppose one-half of the fixed power costs can be avoided if the power unit is shut down:
   (a) How many units of power would have to be purchased externally?
   (b) What is the maximum price the company would be willing to pay for one unit of service supplied externally?

3-6 *Incremental Costs in a Reciprocal Cost System (R. Manes)*

The Darwin Co. has two main products, S and T, each of which is produced in a separate division. In order to produce S and T, the Darwin Co. has two service departments, A and B, which supply intermediate goods and services both to the S and T divisions and to themselves. For the sake of discussion, let A be a materials handling service and B a power generator.

The budget for work to be done by the firm in a coming period is shown in Table 1.

Depreciation expenses are straight-line depreciation of generating equipment in the fifteenth year of an estimated 20-year life, that is to say it is relatively old equipment (although well maintained).

Required

(1) Using the reciprocal allocation method, determine the variable costs of service departments A and B allocated to products S and T.
(2) Choose a basis for allocating the fixed costs of the service departments, and determine the fixed cost allocation to the two products.
(3) Suppose economic conditions change so that product sales are now expected to be $S = 80$ and $T = 90$. Recalculate Table 1, the production schedule, and the service department budget.
(4) What are the new sets of allocated variable and fixed service department costs?
(5) The local utility company offers to sell unlimited amounts of B to Darwin at $130 per unit. Should Darwin accept this offer?

TABLE 1

	SOURCE A	SOURCE B	SOURCE S	SOURCE T
User of Output				
A (materials handling)	0	30	0	0
B (power)	20	0	0	0
Division S	30	35	0	0
Division T	40	55	0	0
Outside markets	0	0	60	100
Total (in units of goods and services)	90	120	60	100
Costs of Service Department	A	B		
1. Variable labor, overhead, and materials costs	$ 7,200	$ 4,800		
2. Supervision and other out-of-pocket fixed costs	6,000	7,000		
3. Depreciation	4,800	8,200		
	$18,000*	$20,000†		

**Plus share of Dept. B's power costs.*
†Plus share of Dept. A's materials handling costs.

■ *CASE STUDY*

SELIGRAM, INC.: ELECTRONIC TESTING OPERATIONS*

We put in a piece of automated equipment a year ago that only fits the requirements of one customer. This equipment reduced the direct labor required to test his components and, because of our labor-based burden allocation system, substantially reduced his costs. But putting a $40,000 machine into the general burden pool raised the costs to our other customers. It just doesn't make sense shooting yourself in the foot at the same time you are lowering the company's cost of operations.

Paul Carte, Manager

Introduction

Electronic Testing Operations (ETO), a division of Seligram, Inc., provided centralized testing for electronic components such as integrated circuits. ETO was created as a result of a decision in 1979 to consolidate electronic testing from 11 different divisions of Seligram. ETO commenced services to these divisions in 1983. It was estimated that centralization would save Seligram in excess of $20 million in testing equipment investment over the next five years.

ETO operated as a cost center and transferred products to other divisions at full cost (direct costs plus allocated burden). Although ETO was a captive division, other divisions within Seligram were allowed to use outside testing services if ETO could not meet their cost or service requirements. ETO was permitted to devote up to 10% of its testing capacity to outside customers but chose to work mainly with other Seligram divisions due to limited marketing resources.

ETO employed approximately 60 hourly personnel and 40 administrative and technical staff members. Budgeted expenses were $7.9 million in 1988 (see Exhibit 1).

Testing Procedures

ETO expected to test between 35 and 40 million components in 1988. These components included integrated circuits (I.C.s), diodes, transistors, capacitors, resistors, transformers, relays, and crystals. Component testing was required for two reasons. First, if defective components were not caught early in the manufacturing cycle, the cost of repair could exceed the manufacturing cost of the product itself. Studies indicated that a defective resistor caught before use in the manufacturing process cost two cents.

EXHIBIT 1 Electronic Testing Operations—1988 Budgeted Expenses

Direct labor		$3,260,015
Overhead		
Indirect labor	859,242	
Salary expense	394,211	
Supplies and expenses	538,029	
Services*	245,226	
Personnel Allocations†	229,140	
Service Allocations‡	2,448,134	
Total Overhead		$4,713,982
Total budgeted expenses		$7,973,997

**Includes tool repair, computer expenses, maintenance stores, and service cost transfers from other divisions.*
†Includes indirect and salaried employee fringe benefits, personnel department, security, stores/warehousing, and holidays/vacations.
‡Includes building occupancy, telephones, depreciation, information systems, and data control.

*This case was prepared by Professor Peter B. B. Turney, Portland State University and Christopher Ittner, Doctoral Student, under the supervision of Professor Robin Cooper.

If the resistor was not caught until the end product was in the field, however, the cost of repair could run into the thousands of dollars. Second, a large proportion of Seligram's work was defense related. Military specifications frequently required extensive testing of components utilized in aerospace and naval products. By 1988, ETO had the ability to test 6,500 different components. Typically, however, the division would test about 500 different components each month and between 3,000 and 3,500 per year. Components were received from customers in lots; in 1988, ETO would receive approximately 12,000 lots of components.

ETO performed both electrical and mechanical testing. Electrical testing involved measuring the electrical characteristics of the components and comparing these measurements with the components' specifications. For example, the specifications for an amplifier may have called for a 1-volt input to be amplified into a 10-volt output. ETO would deliver a 1-volt input to the component. By measuring the amplifier's output, ETO gauged its conformance with specifications.

Mechanical testing included solderability, component burn-in, thermal shock, lead straightening, and leak detection. Solderability involved the inspection of components to see if they held solder. Burn-in was the extended powering of components at high temperature. Thermal shock involved the cycling of components between high and low temperatures. Lead straightening was the detection and correction of bent leads on components such as axial components. Leak detection examined hermetically sealed I.C.s for leaks.

Components varied significantly in the number and type of electrical and mechanical testing procedures they required. This variation resulted in about 200 different standard process flows for the division. Process flows were determined by the different combinations of tests and specifications requested by the customer. Based on these combinations, ETO planners determined the routing of components between testing equipment and the type of tests to be performed at each station. I.C.s, for example, could follow six different flows through the facility. While some I.C.s only required electrical testing at room temperature (solderability and leak detection, for instance), others also required thermal shock and burn-in.

Each type of component required separate software development, and custom tools and fixtures were often required. Software, tools, and fixtures were developed by the engineering group, which was made up of specialists in software development, equipment maintenance, calibration and repair, tooling and fixturing, and testing equipment operation. Software engineers developed programs for specific applications. The programs were then retained in a software library for future use. ETO had 6,500 different software programs on file, of which 1,300 were programs developed in the past year. ETO also had an inventory of 1,500 tools and fixtures, of which 300 had been developed in the past year. The large number of tools and fixtures allowed the testing of components with a wide variety of leads, pin combinations, and mating configurations.

The testing facility was divided into two rooms. The main testing room contained the equipment used for electrical testing. The mechanical room contained the equipment used for mechanical testing, plus incoming receiving and the stockroom. A total of 20 people worked in the two rooms on each of two main shifts, and 10 people worked on the night shift.

Cost Accounting System

The cost accounting system measured two components of cost: direct labor and burden. Burden was grouped into a single cost pool that included burden costs associated with each

EXHIBIT 2 Electronic Testing Operations—Calculation of Burden Rate, Based on 1988 Plan

$$\text{Burden rate} = \frac{\text{Total burden \$*}}{\text{direct labor \$}} \times 100$$

$$= \frac{\$4{,}713{,}982}{3{,}260{,}015} * 100$$

$$= 144.6\%$$

Effective rate = 145%

**Cost breakdown*

		FIXED		
	VARIABLE	DEPRECIATION	OTHER	TOTAL
Total burden	$1,426,317	$1,288,000	$1,999,665	$4,713,982

of the testing rooms as well as the engineering burden costs relating to software and tooling development and the administrative costs of the division. Total burden costs were divided by the sum of testing and engineering labor dollars to arrive at a burden rate per direct labor dollar. The division costed each lot of components. Burden was calculated for each lot by multiplying the actual direct labor dollars associated with the lot by the 145% of burden rate. The resulting burden was then added to the actual direct labor costs to determine the lot's total cost. In 1988, the facilitywide burden rate was 145% of each direct labor dollar, of which more than 40% was attributable to equipment depreciation (see Exhibit 2)

Signs of Obsolescence

Several trends pointed to the obsolescence of the labor-based burden allocation process. Since the founding of the division in 1983, direct labor hours per lot tested had been steadily declining (see Exhibit 3). This trend was aggravated by an increased dependence on vendor certification. Vendor certification was a key component of Just-in-Time (JIT) delivery. With vendor certification, Seligram's suppliers did the primary testing of components. ETO then utilized statistical sampling to verify that the supplier's production process was still in control. Thus, whereas JIT led to an increased number of smaller lots being received by ETO, vendor certification reduced the number of tests performed. Early indications were that JIT deliveries would account for 30% of Seligram's shipments within the next five years.

In addition to declining direct labor content and fewer test lots, the obsolescence of the labor-based allocation system was intensified by a shift from simple inspection services to broader-based test technology. On complex parts requiring screening, environmental conditioning, and testing, the division was consistently cheaper than outside services. Where only elementary testing was required, however, low-technology outside laboratories were often cheaper, especially on large lots. The advantage that the division brought customers over the outside labs was that the latter provided essentially no engineering support, whereas ETO with its resident engineering resources was able to support such service on a rapid and cost-effective basis. The shift to more techni-

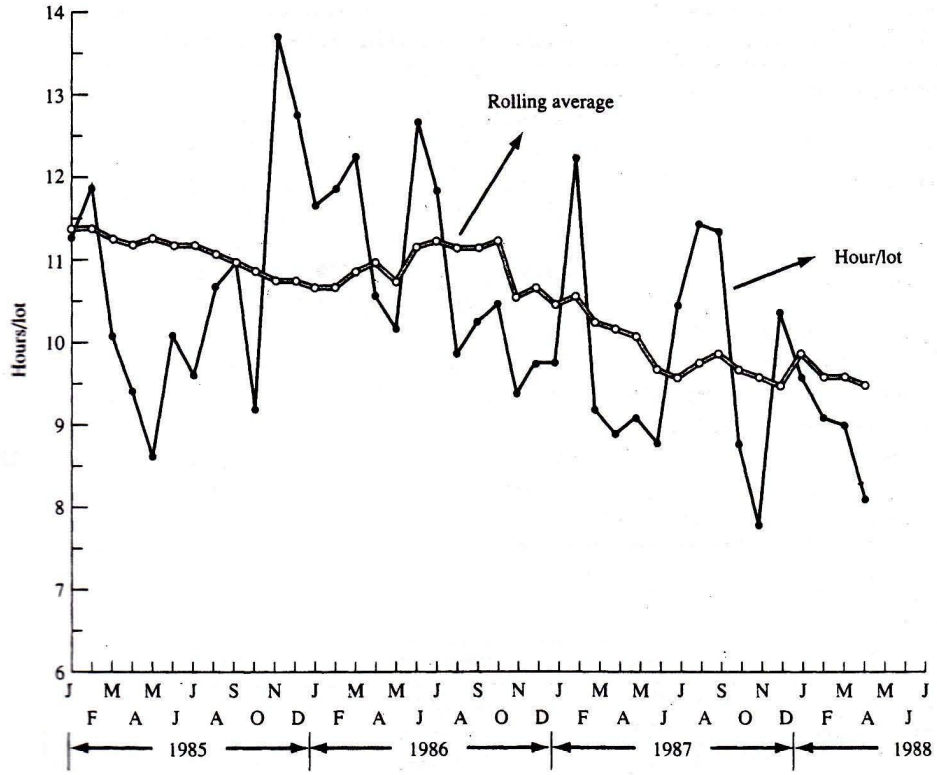

EXHIBIT 3 Electronic Testing Operations—Direct Labor Hours per Lot

cally sophisticated services prompted a shift in the labor mix from direct to indirect personnel. The division expected to see a crossover between engineering head count and hourly head count early in the 1990s.

Finally, the introduction of high-technology components created the need for more automatic testing, longer test cycles, and more data per part. Digital components, for example, were currently tested for up to 100 conditions (combinations of electrical input and output states). The new generation of digital components, on the other hand, would be much more complex and require verification of up to 10,000 conditions. These components would require very expensive highly automated equipment. This increase in automation would, in turn, lead to a smaller base of direct labor to absorb the depreciation costs of this new equipment.

There were fears that the resulting increase in burden rates would drive some customers away. ETO had already noticed an increase in the number and frequency of complaints from customers regarding the rates they were charged for testing.

The division's accounting manager proposed a new cost accounting system to alleviate the problem. Under this new system, burden would be directly traced to two cost pools. The first pool would contain burden related to the administrative and technical functions (division management, engineering, planning, and administrative personnel). This

EXHIBIT 4 Electronic Testing Operations—Proposed Burden Rates, Based on 1988 Plan

Machine Hour Rate

	Machine Hours	Burden $*
Main test room	33,201	$2,103,116
Mechanical test room	17,103	1,926,263
Total	50,304	$4,029,379

Machine hour rate $= \frac{\text{Test room burden \$}}{\text{Machine hr}} = \frac{\$4,029,379}{50,304} = \$80.10$

Effective machine hour rate = $80.00

Direct Labor Hour Rate

Total engineering and administrative burden $ = $684,603

Total direct labor dollars = $3,260,015†

Burden rate $= \frac{\text{Engr. \& Admin. Burden \$}}{\text{Direct Lbr \$}} \times 100 = \frac{\$684,603}{\$3,260,015} \times 100 = 21\%$

Effective burden rate per direct labor $ = 20%

Cost breakdown

		FIXED		
	VARIABLE	DEPRECIATION	OTHER	TOTAL
Main test room	$ 887,379	$ 88,779	$1,126,958	$2,103,116
Mechanical test room	443,833	808,103	674,327	1,926,263
Test Room Burden	$1,331,212	$ 896,882	$1,801,285	$4,029,379
Engineering & admn.	$ 95,105	$ 391,118	$ 198,380	$ 684,603
Total burden	$1,426,317	$1,288,000	$1,999,665	$4,713,982

†*Includes all direct labor costs, including direct labor costs incurred in both test rooms as well as in engineering.*

pool would be charged on a rate per direct labor dollar. The second pool would include all other burden costs and would be charged based on machine hours. Exhibit 4 provides the proposed burden rates.

Shortly after the accounting manager submitted his proposal, a consultant hired by Seligram's corporate management prepared an assessment of ETO's cost system. He recommended the implementation of a three-burden-pool system utilizing separate burden centers for each test room and a common technical and administrative pool. Burden would be directly traced to each of the three burden pools. Like the accounting manager's system, burden costs in the test rooms would then be allocated on a machine-hour basis. Technical and administrative costs would continue to be charged on a rate per direct labor dollar.

To examine the impact of the two alternative systems, ETO management asked that a study be conducted on a representative sample of parts. Exhibit 5 provides a breakout of actual direct labor and machine-hour requirements per lot for the five components selected for the study.

Technological Future

In 1988, the division faced major changes in the technology of testing that required important equipment acquisition decisions. The

EXHIBIT 5 Electronic Testing Operations—Direct Labor and Machine-Hour Requirements, Actuals for One Lot

		MACHINE HOURS		
PRODUCT	DIRECT LABOR $	MAIN ROOM	MECH. ROOM	TOTAL
ICA	$ 917	8.5	10.0	18.5
ICB	2051	14.0	26.0	40.0
Capacitor	1094	3.0	4.5	7.5
Amplifier	525	4.0	1.0	5.0
Diode	519	7.0	5.0	12.0

existing testing equipment was getting old and would not be able to keep pace with developments in component technology. Existing components, for example, had between 16 and 40 input/output terminations (e.g., pins or other mating configurations), and ETO's equipment could handle up to 120 terminations. Although the 120-termination limit had only been reached a couple of times in the past few years, a new generation of components with up to 256 terminations was already being developed. Similarly, the upper limit of frequency on existing components was 20 MHz (million cycles per second), whereas the frequency on the next generation of components was expected to be 50 MHz.

The equipment required to test the next generation of components would be expensive. Each machine cost approximately $2 million. Testing on this equipment would be more automated than existing equipment, with longer test cycles and the generation of more test data per part. It was also likely that lot sizes would be larger. The new equipment would not replace the existing equipment but would merely add capabilities ETO did not currently possess. Additionally, the new equipment would only be needed to service the requirements of one or two customers in

EXHIBIT 6 Electronic Testing Operations—New Testing Equipment Economics and Operating Characteristics

[illegible]	$2 million
[illegible] life	8 years
[illegible] method	Double declining balance (first-year depreciation costs of $500,000)
[illegible]	Main test room
[illegible]	10% first year, rising to 60% by third year and in all subsequent years, based on 4,000 hours per year availability (2 shifts × 2,000-hour year)
[illegible] requirements:	Approximately five minutes per hour of operation; average labor rate of $30 per hour
[illegible] requirements:	$75,000 in installation and programming costs in first year
[illegible] overhead [illegible] engineering [illegible])	$250,000 ($100,000 variable, $150,000 fixed)

the foreseeable future. Exhibit 6 provides a summary of the new equipment's economics and operating characteristics.

The impact of this new equipment would be an acceleration in the decline in direct labor hours per lot of components. At the same time, burden would increase with the additional depreciation and engineering costs associated with the new equipment. This would result in a large increase in the burden rate per direct labor dollar. As Paul Carte, manager of ETO, saw it, the acquisition of the new equipment could have a disastrous effect on the division's pricing structure if the labor-based allocation system remained in use:

> We plan on investing $2 million on a large electronic testing machine to test the chips of one or two customers. This machine will be very fast and will require little direct labor. Its acquisition will have a significant effect on our per direct labor dollar burden rate, which will result in an increase in charges to our other customers. It is clear that a number of customers will walk away if we try to pass this increase on. I am afraid that we will lose 25% of our customer base if we don't change our cost system.