THE CASE FOR RCA: UNDERSTANDING RESOURCE INTERRELATIONSHIPS

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Executive Summary

● The first article in this series on resource consumption accounting (RCA) proposed a mapping method to analyze and manage the resource side of ABC (activity-based costing)—that is, the investments made to provide useable capacity.

● In this second, article, the presentation of the RCA solution continues. The three shortfalls of ABC are addressed: 1.) the interrelationships between resource pools are only indirectly expressed, 2.) the changing nature of cost at the time of consumption is not reflected, and 3.) the fully burdened resource costs are not provided.

● The characteristics of resource pool interrelationships and the demands they place on the cost management system are highlighted, including an exploration of cost dynamics at the time of consumption and an evaluation of resource pool interrelationships from an ABC perspective. In addition, the RCA solution to these shortfalls is explained and evaluated. Finally, the need for fully burdened resource costs is discussed and its advantages highlighted.

Interrelationships of resources refer to dependencies between resources that enable them to provide their respective services. Managers need to clearly understand resource interrelationships and dependencies, or they may make decisions that are more costly and less efficient than they at first appear. Four characteristics of these interrelationships are identified:

● They are functions of the resources deployed.
● They are often reciprocal.
● They are resource-output quantity based.
● They affect the nature of cost.

Each characteristic is discussed in detail in the following sections.

FUNCTIONS OF THE RESOURCES DEPLOYED

The deployment of a particular resource for a desired function requires the deployment of support services with their respective functions. Before the advent of computers, for example, information technology (IT) departments did not exist; nowadays, the fact that
employees are provided with desktop computers necessitates IT support. Exhibit 1 illustrates typical resource interrelationships. Two methods can be used to reflect these relationships: the direct method and the intermediary object method.

The first method expresses the relationship directly. For example, relationship 2 in Exhibit 1, square footage is provided to the human resources department. Many resource interdependencies are direct and obvious; however, it is not always practical to establish direct relationships, hence the need for a second method.

An activity, as defined in activity based costing (ABC) models, isolates a discrete portion of the output of a resource and is well suited to reflect the relationship. In relationship 1 in Exhibit 1, for example, procurement purchases furniture for human resources. The second method uses the purchase order to charge human resources for services rendered. This first characteristic requires the accurate reflection of resource interrelationships. Moreover, it requires that the causal relationship be taken to its logical conclusion by placing the burden on the actual consumer of the resources.

Exhibit 1.

Sample Resource Pool Interrelationships

![Sample Resource Pool Interrelationships](image_url)

RESOURCE INTERRELATIONSHIPS ARE OFTEN RECIPROCAL

Resources perform services for each other and, often, do so indirectly. Even within the limited representation in Exhibit 1, relationships can be complex. For example:

- Relationship 5—Plant maintenance repairs utilities infrastructure.
- Relationship 3—Utilities are consumed by facilities for lighting.
- Relationship 1—Human resources performs payroll processing for procurement.
- Relationship 6—Procurement purchases cleaning materials for facilities.

This characteristic dictates a simultaneous, rather than sequential, cost model to accurately model cost flows and correctly burden the consumers of resources.

RESOURCE INTERRELATIONSHIPS ARE RESOURCE-OUTPUT-QUANTITY BASED

Interrelationships are resource-output-quantity based as opposed to value based. For example, the number of hours a machine is used determines the number of kilowatt-hours it consumes, which in turn determines electricity expense. Hence, a causal relationship exists between the consuming resource pool output quantity (i.e., the number of machine hours) and the supporting resource pool output quantity (i.e., the number of kilowatt-hours).

This output-quantity to output-quantity relationship applies to all resource relationships, even those not traditionally viewed as quantity based. It should be noted that some resource-pool to resource-pool relationships can be expressed in output quantities that are not as entirely proportional as those in the illustrations used. These are discretionary and fixed-quantity consumptions of support resource output, which will be discussed in a later section. In relationship 4, of Exhibit 1, for example, as plant maintenance output increases demand for general materials that technicians use in executing work, procurement activities also increase. This leads to more purchase orders and, therefore, more procurement labor hours. Consequently, the same output quantity correlation exists between
plant maintenance hours and procurement hours. To reflect this third characteristic, output quantities must be used to define relationships.

**THE CHANGING NATURE OF COST AT THE TIME OF CONSUMPTION**

Interrelationships affect the nature of cost as quantities flow through the cost model. It should be noted that all consumers of resources, such as other resources, products, and profitability segments, can result in changes in the nature of cost at the time of consumption. Even the classic variable costs (i.e., electricity) are affected. Consider an automotive manufacturer, for example, that invested in a furnace to melt aluminum ingots for casting of gearbox housings.

The furnace produces molten metal for only two eight-hour shifts. As a result of the expense incurred to reheat the furnace before the first shift, it is kept running around the clock. During the third shift, a temperature is maintained just above the melting point for aluminum, and electricity expense incurred during this time is considered a fixed expense. During regular production shifts, electricity consumed over and above the fixed expense is proportional to furnace output.

The furnace consumes megawatt-hours (MwHs) from utilities—15 MwHs during the third shift and 184 MwHs during the shifts in which it is actually being used. Utility output has a fixed cost of $100 per MwH and a proportional cost of $50 per MwH. Exhibit 2 illustrates the four possible scenarios and the impact on the nature of cost during consumption as follows:

- **Scenario 1**—The MwHs consumed is fixed (i.e., 15) and the cost is fixed (i.e., $100 per MwH). The result is $1,500 of fixed expense. Because the MwH quantity consumed is fixed and the initial inherent nature of cost is fixed, the expense is a fixed cost to the furnace. Under Scenario 1, the nature of cost remains fixed.
- **Scenario 2**—The MwHs consumed is fixed (i.e., 15) and the cost rate is proportional (i.e., $50 per MwH). The result is $750 of fixed expense. Because the MwH quantity consumed is fixed, the cost for utilities is a fixed expense to the furnace. Under Scenario 2, the initial inherent nature of cost changes from proportional to fixed.
- **Scenario 3**—The MwHs consumed are proportional (i.e., 184) and the cost rate is fixed (i.e., $100 per MwH). The result is $18,400 of fixed expense. Although the MwH quantity consumed is proportional, the cost for utilities is a fixed expense to the furnace because the initial inherent nature of cost is fixed. Under Scenario 3, the nature of cost remains fixed.
- **Scenario 4**—The MwHs consumed are proportional (i.e., 184) and the cost rate is proportional (i.e., $50 per MwH). The result is $9,200 of proportional expense. Because both the MwH quantity consumed and the initial inherent nature of cost are proportional, the cost remains a proportional expense to the furnace. Under Scenario 4, the nature of cost remains proportional.

Note that costs can only become more fixed as they flow through the cost model. In addition, building on the process cost curve introduced in the first article (see “The Case for RCA: Excess and Idle Capacity,” Volume 15, Number 4), Sidebar A highlights the implications for ABC information in light of the changing nature of cost. This fourth characteristic of resource interrelationships requires the accurate reflection of the changing nature of cost.

**Sidebar 1.**

**Sidebar A: The Changing Nature of Cost and ABC Information**

The principles inherent in resource consumption accounting have two implications for activities and the nature of cost. First, the consuming resource pool alone determines the change in the nature of cost. Therefore in relationships expressed in terms of activities, the nature of cost is not influenced by the activity. As illustrated in the first article in this series, activities serve as vessels for resource cost transmission, both for value and the nature of cost according to resource interrelationships.

Second, because the value chain does not influence the nature of cost, the resource output that activities consume is proportional quantity consumption. The costs of a process are not 100% proportional/variable. Instead the resource output quantity being consumed carries inherent variability and proportionality. This is in accordance with the recognition that resources can be fungible.

Resources typically used to perform a particular activity, that is not currently being performed, are available to perform other activities or the resources remain idle. ABC correctly focused on operationally meaningful units (i.e., activities), but could benefit from a more accurate understanding of the resources those activities consume in order to function. If activities are the smoke, resources are the fire.
EXPRESSING RESOURCE INTERRELATIONSHIPS THROUGH ABC

As activity-based practices developed, a range of approaches surfaced to assign and allocate costs to reflect resource interrelationships. Initially, these varied from simple to more advanced approaches during the late 1990s. There are two extremes on this continuum. The first is a simple two-phase method that includes maps and traces resources to activities and charges cost objects for the activities consumed. The second is a four-phase method that transfers expenses between cost centers in which an activity adds no value (e.g., floor space), assigns expenses to activities (i.e., mapping or tracing or quantities are used), allocates costs between activities (i.e., either step down or simultaneous), and charges primary activities to cost objects.

A popular approach maps and traces resources to activities and allocates secondary activities to primary activities before finally charging primary activities to cost objects (see Exhibit 3). Evaluating ABC’s effectiveness to reflect resource interrelationships considers only the two extremes on the allocation continuum listed previously. The points made can be extrapolated to other ABC assignment and allocation methods.

Evaluating the Two-Phase Method

The archetypal reference of this approach is the CAM-I cross (see Exhibit 4). This method remains popular because of its simplicity.
and theoretical appeal. It reflects the four characteristics of resource interrelationships as follows:

- Interrelationships are functions of the resources deployed—Note that attention is focused on activities without attendant consideration being given to resource interrelationships. Costs are mapped and traced to activities and then activities are charged to cost objects.
- Interrelationships are often reciprocal—Reciprocal relationships are not reflected.
- Interrelationships are resource-output-quantity based—Mapping or tracing seldom, if ever, uses carefully understood resource output quantities.
- Interrelationships affect the nature of cost—The changing nature of cost is not considered.

Exhibit 4.
The CAM-1 Cross

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Evaluating the Four-Phase Method

The four-phase method evolved from the two-phase method as its theoretical simplicity was overwhelmed by the complexity of actual operational practice. This evolution was gradual and is represented by movement along the allocation continuum from overtly simplistic to more realistic and sophisticated. The four-phase method more accurately reflects resource interrelationships but still falls short of sufficient resource insight:

- Interrelationships are functions of the resources deployed—Limited direct consumption of services occurs frequently. Resource interrelationships are primarily reflected by allocations between activities.
- Interrelationships are often reciprocal—The need for simultaneous allocations is recognized. An activity focus prevails, however, and simultaneous allocations usually occur only between activities and not between resources and usually not between activities and resources.
- Interrelationships are resource-output-quantity based—Recognition of quantity-based relationships has surfaced among leading ABC theorists; it is not, however, widely used in practice. 3
- Interrelationships affect the nature of cost—The changing nature of cost is not reflected.

INACCURATELY REFLECTING RESOURCE INTERRELATIONSHIPS

If resource interrelationships are insufficiently reflected, several implications exist for ABC relating to:

- Cost model complexity.
- Cost model flexibility.
- Cost model maintenance.
- Accuracy of data and quality of decision support.
These items are discussed in the following section.

**Implications Relating to Cost Model Complexity**

If an ABC model were to reflect resource interrelationships, the model would quickly become more complex. Reflecting the interrelationships at the activity level leads to a proliferation of associations. In a one-way relationship between two resource pools, for example, where each resource pool performs five activities, 25 relationships must be established—that is, five senders to each of five consumers compared to the original single relationship. In a reciprocal relationship, this number doubles, to 50. In a full-blown simultaneous cost model, the number of relationships becomes prohibitively large.

**Implications Relating to Cost Model Flexibility**

A complex cost model is inherently less flexible, a problem exacerbated by mapping or tracing costs, a method akin to hard coding variables in computer code. This rigidity results from using percentages, ratios, or fixed amounts for allocating costs. Once the relationship is defined, for example, 40% of account 123 to activity ‘XYZ’, it is cast in stone, until a model redesign is discussed and approved.

In practice, resource-to-resource and resource-to-activity relationships change continuously, but typical ABC cost models change only when human intervention redefines and recodes the relationship. In addition, using the ABC method, this inflexibility can apply to relationships established among activities. Moreover, standard fluctuations occur in the mix of activities that a department performs, and the cost model quickly becomes outdated.

**Implications Relating to Cost Model Maintenance**

A cost model, unable to adjust automatically to changes, demands high maintenance to remain current. Using an ABC approach, cost models are arrived at through a project-sized effort of interviews, documentation, reconciliations, and test models. If some or all of these tasks must be revisited regularly, frequent updates become cost prohibitive, if not impossible. ABC models are therefore updated infrequently in practice (e.g., every three to six months and, in some cases, annually).

**Implications Relating to Data Accuracy and Decision Support Quality**

Attempting to strike a balance between inflexibility and maintenance, ABC models can compromise accuracy; therefore, at any point in time, the model may not reflect the environment that it strives to mirror. Moreover, a typical ABC model has the primary aim (almost a preoccupation) of flowing costs to activities. This means that the real consumers of support services (i.e., resource pools) are not burdened with all attributable costs.

Each resource pool serves as the source of the costs for its own activities and is unable to pass fully burdened costs onto them. This has negative implications for accuracy of costs on activities and products. In addition, the lack of a simultaneous cost model negatively affects accuracy. Finally, ABC does not reflect the changing nature of cost at the time of consumption. (As is shown in the final article in this series, these factors have considerable implications for decision support.)

**RCA AND RESOURCE INTERRELATIONSHIPS**

The question remains whether RCA methods can solve these issues. To begin to answer that question, examples of the direct and the intermediary object methods of expressing resource interrelationships using RCA are discussed in subsequent sections. Before presenting these discussions, however, two further classifications of costs and resource pools are introduced—namely, primary and secondary resource pools and primary and secondary costs. As an integral part of the solution, their application is demonstrated in subsequent sections and in the final article in the series. (For more detailed information on these two types of costs see Sidebar B).

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**Sidebar 1.**

**Sidebar B: Primary and Secondary Resource Pools and Expenses**

Primary resource pools perform activities that result in saleable goods and services or contribute directly to saleable goods and services—for example, production departments, marketing, distribution and customer complaint departments. [See W. Kilger, *Flexible Plankostenrechnung*]
RCA: The Direct Method of Expressing Resource Interrelationships

Returning to the automotive manufacturer example cited earlier, the following discussion details the RCA solution for the direct method of expressing interrelationships.

If the planned output quantity of the utility resource pool is measured in MwHs and the total output is 500 MwHs, the proportional amount of electricity expense is $75,000 (no fixed amount) and the utility cost per unit is $150 ($75,000/500 = $150).

If the planned output of the furnace resource pool is measured in kilograms (Kgs) of molten aluminum and the desired output is 2,000 Kgs, the fixed amount of equipment depreciation is $125,000 (no proportional amount).

Consumption rates are key to RCA calculations. In this example, for every kilogram of molten aluminum produced, the furnace consumes 0.092 MwHs (i.e., 0.092 x 2000 = 184)—a proportional quantity consumption. The relationship between the two resource pools is expressed in output quantities in the secondary cost section. Proportional electricity expense is calculated as $27,600 (184 x $150). The proportional rate, therefore, is $13.80 ($27,600/2000 Kgs).

Moving to the fixed calculation, the previously mentioned “third shift” comes into play. The furnace is left switched on during the third shift and consumes 15 MwHs during this time—a fixed quantity consumption. Therefore, in addition to fixed equipment depreciation expense ($125,000), fixed electricity expense is calculated at $2,250 (15 x $150). Because the quantity consumed is fixed, all of the dollars associated with this quantity in the fixed cost category. Thus, the total fixed cost comes to $127,250 and the fixed rate is $63.62 ($127,250/2,000 Kgs).

See Exhibit 5 or a graphical representation of this example.

Exhibit 5.

Quantity Relationships Between Two Resource Pools
**RCA: The Intermediary Object Method of Expressing Resource Interrelationships**

Similar to the interrelationships between resource elements introduced in the first article in the series, more complex relationships can also exist between resource pools. One such example includes the relationship between plant maintenance and human resources for the processing of overtime tickets. This relationship depends on plant maintenance first exceeding its standard capacity before overtime applies. Hence, the relationship is linear, depending on reaching a threshold value of output.

**RESULTS FOR RCA**

For both methods of expressing the interrelationships, resource consumption accounting is able to reflect all four characteristics of resource pool interrelationships effectively. It does so by reflecting the initial inherent nature of cost in unit output cost rates, using quantities to express the relationships, and accurately reflecting the changing nature of cost at the time of consumption in a simultaneous cost model.

**ADVANTAGES OF THE RCA APPROACH**

The implications of the current inability of ABC to reflect resource interrelationships fully have been demonstrated. In the next sections, the advantages of the RCA approach are discussed.

**Implications Relating to Cost Model Complexity**

RCA requires fewer relationships to be defined. Use can be made of direct resource-to-resource relationships. Moreover, activities charge their consumers directly, one consumer per resource pool instead of many activities in ABC, thereby leading to a significantly reduced number of consumers and relationships to be defined and maintained (see Exhibit 6). Because individual relationships are quantity based, however, they will be more complex.

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### Exhibit 6

**Section A: The Utility Resource Pool**

<table>
<thead>
<tr>
<th>Output Measure — Megawatt hours (MwHs)</th>
<th>Output Quantity — 500 MwHs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary Costs</strong></td>
<td><strong>Secondary Costs</strong></td>
</tr>
<tr>
<td>Electricity Expense</td>
<td>None</td>
</tr>
<tr>
<td>Fixed</td>
<td>Proportional</td>
</tr>
<tr>
<td>0</td>
<td>$75,000</td>
</tr>
<tr>
<td>Proportional</td>
<td>Fixed</td>
</tr>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Proportional</td>
<td>Proportional</td>
</tr>
<tr>
<td></td>
<td>Rate</td>
</tr>
<tr>
<td></td>
<td>$150</td>
</tr>
</tbody>
</table>

Utility Output Unit Cost = $75,000/500

**Section B: The Furnace Resource Pool**

<table>
<thead>
<tr>
<th>Output Measure — Kgs of Molten Aluminum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Quantity — 2,000 Kgs, each Kg consumes 0.092 MwH</td>
</tr>
<tr>
<td><strong>Primary Costs:</strong></td>
</tr>
<tr>
<td>Equipment Depreciation</td>
</tr>
<tr>
<td><strong>Secondary Costs:</strong></td>
</tr>
<tr>
<td>Utilities</td>
</tr>
<tr>
<td>MwH $</td>
</tr>
<tr>
<td>Totals:</td>
</tr>
<tr>
<td><strong>Furnace Output Unit Cost Rates:</strong></td>
</tr>
</tbody>
</table>
Implications Relating to Cost Model Flexibility

Contrasting ABC, an RCA model does not depend on redefining relationships to keep the model current. Instead, relationships are based on unit quantity standards for output-to-output correlation. If maintenance output declines from 20,000 to 18,000 hours, for example, fewer proportional purchase orders are required and the demand for procurement output hours will likewise decrease.

Consequently, only one driver in a chain of events needs to be collected (e.g., maintenance output). Other drivers (e.g., the number of purchase orders and procurement hours) can be imputed as needed. Moreover, to the extent that unit quantity standards are used throughout a cost model, one dependent variable leads to a series of related adjustments. A cost model based on resource consumption accounting is therefore inherently more flexible and able to adapt to changes in the environment without the need for human intervention.

Implications Relating to Cost Model Maintenance

As a result of reduced complexity and enhanced flexibility, RCA eliminates the ABC problems in keeping relationships current and dynamically assigning costs where they are consumed. From a systems perspective, it is possible to introduce a set-and-forget-environment (i.e., SAFE) system, whereby the model is defined once and thereafter adapts to changes automatically, within certain parameters.

Implications Relating to Data Accuracy and Decision Support Quality

All four of the characteristics of resource pool interrelationships are reflected in a comprehensive simultaneous model, which provides more accurate data. Moreover, having eliminated the ABC compromise—balancing inflexibility and maintenance—resource consumption accounting enables accurate ABC information on a perpetual basis. Highly relevant data is supplied and decision support is enhanced.

THE PROCESS VIEW OF COSTS AND FULLY BURDENED RESOURCE COSTS

If the resource consumption accounting approach is examined from a purely ABC perspective, the likely reaction is that the process view of cost is lost to some degree. Costs flow directly between resource pools without going through activities and, worse still, resources consume activities. Two challenges of the process view warrant more discussion. First, the process view of costs and causal cost flows are not synonymous. Second, it is a serious oversight to fail to provide fully burdened resource costs.

The Process View of Costs and Causal Cost Flows Are not Synonymous

Attempts to mimic the causal consumption patterns that are the result of resource interrelationships within activities is cumbersome and, at best, results in an approximation. On the other hand, in resource consumption accounting, more accurate fully burdened...
activity costs are obtained with interrelationships explicitly reflected between resources. Hence, not only is the process view of costs and causal relationships not synonymous, the accuracy of the former depends on not equating causal cost flows to perceived direct process interrelationships.

**Fully Burdened Resource Costs Are Essential**

Explicitly reflecting resource interrelationships results in fully burdened resource pool costs. These serve as the source of costs for their own activities. The resultant fully burdened activities have the following advantages:

- More accurate activity costs.
- More accurate product costs.
- More effective decision support.

More effective decision support is particularly crucial because it is closely related to the fixed cost death spiral and is an area in which ABC has been known to fail to supply adequate information.

**CONCLUSION**

In the previous sections, three shortfalls of ABC related to resource interrelationships have been addressed. Eight shortfalls were examined in the first article in the series; therefore, one shortfall remains—ABC provides inferior information for effective resource management and certain strategic decisions. This final point will be addressed in the last article in this series. A fully developed example of a resource pool within the resource consumption accounting solution will be used to illustrate how fully burdened resource costs can be used for enhanced product make-buy and resource outsourcing decisions.

**EDITORS' NOTE:**

This is the second in a series of articles on resource consumption accounting (RCA) by Anton van der Merwe and David E. Keys. The introductory article, “The Case for RCA: Excess and Idle Capacity,” appeared in the July/August 2001 issue of the Journal of Cost Management (Volume 15, Number 4). In the introductory article, the authors built on predecessors' developments in German cost accounting and seminal work by such leading industry theorists as Robert S. Kaplan and Robin Cooper. Kaplan and Cooper set the foundations for measuring and managing activities that consume an organization's resources in several articles published from 1990 to 1995 and in their 1998 book, Cost and Effect.

The first article highlighted the following eight shortfalls of viewing resources from an activity-based costing perspective:

1. Visibility of a homogeneous measure of capacity is not incorporated.
2. The interrelationships between resource elements are only indirectly expressed.
3. The initial inherent nature of cost is not reflected.
4. Excess or idle capacity is not properly accounted for.
5. Interrelationships between resource pools are only indirectly expressed.
6. The changing nature of cost at the time of consumption is not reflected.
7. Fully burdened resource costs are not provided.
8. Inferior information is provided for effective resource management and certain strategic decisions.

In the first article, the authors addressed the first four shortfalls by introducing RCA as the complementary solution that provides focus on and more direct expression of the interrelationships between resource elements.

This second article in the series is especially helpful for managers who use ABC systems that were first implemented 5-to-10 years ago and that have undergone minimal design changes since then. RCA concepts can assist in updating such models to deliver more valuable decision-making information.

Companies interested in receiving more information about RCA should contact the authors (anton.van.der.merwe@us.pwcglobal.com or dkeys@niu.edu). Also, the Consortium for Advanced Manufacturing—International (CAM-I) CMS program has initiated an RCA
exploratory group, which will convene in San Diego for the next quarterly meeting, in December 2001. Please contact Ron Bleeker for more information at bleeker@cam-i.org or (817) 860-1654, ext. 121.


3 J.A. Brimson and J. Antos, Driving Value Using Activity-Based Budgeting, (Wiley: New York, 1999), pp. 78-86. See also Chapter 8, “Creating An Activity Budget with Features.”