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The electronic computer makes possible an entire new approach to the chart of accounts, in which a whole series of necessary outputs can be derived from one input —

TOWARD AN INPUT-ORIENTED CHART OF ACCOUNTS

by John W. Wagner
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ONE WAY of making accounting into a more useful and flexible information system would be to develop an *input-oriented* chart of accounts for computerized accounting systems. The purpose of this article is to move toward this goal by (1) clarifying the concept of "input orientation," (2) showing some of its implications for computer applications in accounting, especially as they apply to the chart of accounts, and (3) indicating why the concept probably must be confined to use in computer systems as opposed to manual systems.[1]

When the computer was first introduced into accounting applications, the natural tendency was simply to transfer to the computer the manual system that then existed. The basic conceptual limitations that the manual system implicitly imposed on the computer system were not at first comprehended or challenged. However, as additional experience was accumulated, one of the limitations was clarified when two new distinctions were made, i.e., the difference between an "input-oriented system" and an "output-oriented system."[2]

In an output-oriented system, the older and more familiar of the two, the questions to be answered by the system are formulated in advance.[3] One usually speaks of this as clarifying the "purpose" or "objective" of the system. After this step has been accomplished, the data (or input) are limited to those which will produce the specific type of output necessary to answer the questions that were formulated earlier.

This kind of system is relatively simple and economical, capable of efficiently satisfying only its preconceived needs, and therefore limited in its usefulness. Its qualities are those which can be readily

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[1] For our purposes, manual and mechanical systems will be considered to be the same, since they are different more in degree than in kind when compared to electronic systems.

[2] Robert H. Gregory and Richard L. Van Horn, *Automatic Data Processing Systems*, Second Edition, Wadsworth Publishing Co., Inc., Belmont, California, 1963, p. 566; *Accounting and The Computer*, American Institute of Certified Public Accountants, Inc., New York, N.Y., 1966, pp. 276-277 (a reprint of A. F. Moravec, "Basic Concepts for Planning Advanced EDP Systems," *Management Services*, May-June, 1965, pp. 54-55.)

[3] For example, what is the firm's financial position at the end of the period (the balance sheet), or what is its net income for the period (the income statement)?

recognized as inherent in a manual technology.

Input-oriented system

In an input-oriented system, there is little or at least much less concern with an advance definition of the specific questions to be answered. Instead, the concern is that as many different types of data as possible are integrated into the system. After that, any question is permitted that some combination of the data can answer. This kind of system is relatively detailed and complex, capable of satisfying many specific and general needs simultaneously, and has wide usefulness.

However, in the absence of some new technology such as the computer, it is highly improbable that such a system can be made a practical or economical reality.

Even given the fact that the computer has been a reality for some time, there still remains the task of devising means to incorporate in increasing degree an input orientation into accounting systems. We believe this can best be done by the manner in which the chart of accounts is formulated and utilized.

Chart of accounts

The chart of accounts, as it is usually treated today, is a list of account classifications which is directly tied to the periodic financial statements, the *output* of the accounting system. It is intended that the general ledger accounts summarize data in the same (or similar) manner as they are needed for the financial statements. Thus, while it is not always expressly stated, when we say "chart of accounts," we mean "output-oriented chart of accounts."

Definitions

There is no conceptual reason why we could not also give an input-oriented meaning to the chart of accounts. The word "account" means a "formal record of a particular type of transaction . . . ,"[4] and the word "transaction" means "an *event* . . . or *condition* . . . the *recognition* of which gives rise to an entry in accounting records."[5] Thus, transactions by their very nature are the material from which accountants create the initial inputs into the accounting system, and so it seems quite clear that an "account" can be a record implying types of input as readily as one implying types of output, if not more so. For our purposes, therefore, a distinction will be made between the two cases. The one will be called an "output chart of accounts" and the other an "input chart of accounts"—each term merely implying a different method of preparing a "record of transactions."

Account classifications

In order to clarify the conceptual differences, similarities, and connections between these two types of account classifications, the diagram shown in Exhibit 1 below represents input and output at various possible levels of abstraction.

EXHIBIT I

Levels of Abstraction
(from high to low)

(9) ....../Output 5
(8) Input 2/Output 4
(7) ....../Output 3
(6) ....../Output 2
(5) Input 1/Output 1

The levels of abstraction, starting at (9) and moving downward to (5) in the diagram, refer to the degree to which descriptions of concrete events such as transactions have been generalized. In generalizing, certain specific qualities of the events are selected for emphasis while others are obscured

> ***. . . . transactions, by their very nature are the material from which accountants create the original inputs into the accounting system, and so it seems quite clear that an "account" can be a record implying types of input as readily as one implying types of output . . . .***

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[4] Eric L. Kohler, *A Dictionary for Accountants*, Third Edition, Prentice-Hall, Inc., Englewood Cliffs, N.J., 1963, p. 6.

[5] Ibid., p. 496.

or completely eliminated. For example, if we were told that the total sales of a company were $30,000, this would probably be useful information in itself. If we were told, in addition, that the sales of Departments A and B of the company were $10,000 and $20,000, respectively, we would obviously know even more about the company. By moving from one level of abstraction to a lower one, we have obtained more detailed information about the underlying concrete events.

Level of abstraction

While sales by department are clearly less abstract than the total sales of the company, both are far removed from a detailed description of concrete events. For instance, we still could not answer such questions as how much of the sales were for cash or credit, by product line or supplier, etc. This absence of complete information, which is the usual case, is the reason that the lowest level of abstraction is started at (5) instead of (1) in the diagram. Specifically, this is intended to indicate that every event or transaction is so unique and has so many unique qualities that no manual or computer system is capable of starting with anything sufficiently detailed to be called "concrete." Each system simply starts at the lowest level of abstraction commensurate with its capacity. However, it should not be too difficult to accept the statement that a computer system is capable of effectively processing descriptions far more numerous and detailed than a manual system. It is this difference in ability to handle details that forces the manual system toward a restriction in favor of the output side, while allowing the computer system to accept fewer restrictions and move farther toward the input side.

As shown on Level (5) in the diagram, it is possible to have both input and output on the same level since they are interrelated. By "input" we mean the various *data* that are initially introduced into the system regardless of the level of abstraction at which we choose to make them an input. By "output" we mean the *information* that is produced by combining the given inputs in some way. The information or output for any one set of circumstances may become the data or input for another, but the level of abstraction present in the output in any case can never be lower than the particular input from which it is derived. However, at the lowest level possible in a particular system they may be said to be synonomous, i.e., they are on the same level. In other words, a computer system cannot "tell us" anything more than we have already "told it."

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Input levels

Two levels of input are given in the diagram, Input 1 and Input 2, to show that it may not always be desirable or possible to have all of the input at the same level of abstraction. As one example, sales tickets for the current period would provide data at one level of detail with which to increase the accounts receivable account, but the beginning balance of the account, also an input in the current period, would be at a higher level. The details of the beginning balance would have been reviewed in the previous period. By giving more detailed treatment to the sales tickets, attention is directed more closely to the activity of the current period. Thus, input may be at numerous levels, whether output- or input-oriented accounts are used.

The various levels of output, ranging from (1) upward to (5) in the diagram, indicate increasing degrees of abstraction in the information produced by the given system. For example, sales of Departments A and B might be Output 4, and the total sales of the company might be Output 5. In regard to the output, moving upward on the scale of abstraction is usually easier than moving downward. That is, if we were told the sales of the two departments and asked what the total sales of the company were, we could develop an answer from the information already provided. But if we were told the total sales of the company and asked what the sales of each of the two departments were, we could not answer without first obtaining additional data.[6] From this reasoning, it can be inferred that it is desirable to maintain accounts at the lowest level of abstraction possible, whether they are output- or input-oriented.

Concrete example

If we were to have an Input 1 at Level (5) resulting in an Output 1 at Level (6), we would have an instance where the accounts were not necessarily maintained at the lowest level of abstraction possible. Take a more concrete example—if sales tickets are received as inputs from the two departments, they could be given account codes indicating department, terms of sales, product line, etc., or they could be given one account code which would summarize the sales of the company in one total. In the latter case, Output 1 produced by the system would be at a higher level of abstraction than is in fact possible given Input 1, and so special analyses of the detailed input would be necessary if information other than the total sales of the company became desirable at some later time. It is this difficulty of predicting in advance what information is likely to become desirable that causes so much need for special analyses in output-oriented accounts. Since input-oriented accounts are less concerned to begin with in predicting which specific questions are likely to be asked, the need for such special analyses would tend to be reduced.

Transaction-related coding

If an Input 1 at Level (5) resulted in an Output 1 at Level (5), as is shown in our diagram, we would have a case where we had successfully brought the lowest level of output possible down to the lowest level of input possible in the particular system. For instance, if our initial account code had defined qualities at the lowest level of abstraction possible in regard to the input, that same code would have determined the lowest level of output the system could effectively produce. Of course, where the two lowest levels of each have become synonomous, we would have a fully input-oriented system. But to the extent the input is not immediately coded for the lowest level possible under the circumstances, only the information then thought desirable would be retained. The remainder of the information would be lost, probably because the coding is initially aimed at answering certain preconceived questions. In such a case, the lowest level of input that would have been possible if proper coding had been used, and the lowest level of output that would in consequence become possible, would no longer be synonomous. *In general, then, the more the coding specifically relates to the particulars of the given transactions, the more input-oriented the chart of accounts will be. Conversely, the more the coding specifically relates to the information it is thought desirable the system produce, the more output-oriented the chart of accounts will be.*

Designing an input system

Having stated the conceptual basis for the differences, similarities, and connections between an input and output chart of accounts, we will now examine a hypothetical example of system design using the concept of input orientation, although the example must be highly oversimplified in a presentation as brief as the one we are providing here. Assume that we are examining a retail organization with:

(1) 3 locations where L equals locations (L_1, L_2, L_3)
(2) 3 terms of sales where T equals terms (T_1, T_2, T_3), and
    a. T_1 designates sales for cash
    b. T_2 designates sales on 30-day open accounts
    c. T_3 designates sales on 90-day installment accounts

In such a case, since the relationships to be considered have been initially limited to three loca-

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[6] John Edmund Butterworth, *Accounting Systems and Management Decision; An Analysis of the Role of Information in the Management Decision Process,* unpublished dissertation: University of California, Berkeley, California, 1967, p. 63. In Butterworth's terms, the ability to move downward in the level of abstraction is referred to as making an accounting system "reversible."

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. . . the less restricted computer system can move toward the input side

tions and three terms of sale, only nine types of sales transactions (3 times 3) are assumed possible at the lowest level of abstraction. These nine combinations of initial inputs may be expressed in a matrix as shown in Exhibit 2 immediately below.

EXHIBIT 2

Transactions Matrix

$$\text{Terms}\left\{\begin{array}{cccc} & \multicolumn{3}{c}{\overbrace{\text{Locations}}} \\ & L_1 & L_2 & L_3 \\ \hline\hline T_1 & I_1 & I_2 & I_3 \\ \hline T_2 & I_4 & I_5 & I_6 \\ \hline T_3 & I_7 & I_8 & I_9 \end{array}\right\}\text{Input}$$

In addition, since two types of sales are for credit, there are six types of cash collections on accounts possible (2 times 3). In matrix form, these may be expressed as shown in Exhibit 3 below.

EXHIBIT 3

Cash Collections Matrix

$$\text{Terms}\left\{\begin{array}{cccc} & \multicolumn{3}{c}{\overbrace{\text{Locations}}} \\ & L_1 & L_2 & L_3 \\ \hline\hline T_2 & I_{10} & I_{11} & I_{12} \\ \hline T_3 & I_{13} & I_{14} & I_{15} \end{array}\right\}\text{Input}$$

Taking both matrices into account, there are fifteen types of transactions possible at the lowest level of abstraction in the partial system we are assuming here. Reading from the matrices, the fifteen transactions which can be used as initial input are shown in Exhibit 4 on page 49.

Having restricted the initial input to these fifteen types of transactions, we can now determine the number of questions that might be answered by combining the totals of these fifteen transactions in various ways. If the arrangement of the transaction totals is a significant part of the answer, the totals can be combined to answer fifteen factorial questions. Fifteen factorial is computed by multiplying 15 times 14 times 13, and so on to times 1. This comes out to a little more than one trillion answers. Of course, detailed analysis will show that many of these answers are, in effect, duplications or related to questions which it is unlikely we would ever ask. On the other hand, some of these answers might be for questions we should have been asking all the time. In any case, in an ideal information system it would not be necessary to make such an analysis. An ideal information system would be capable of answering any of these one trillion questions as soon as the need arose without going through any long involved special analysis, before or after the need became apparent. The way to achieve this capability in an information system is by use of an input chart of accounts.

Twenty-two inputs

In our partial system, twenty-two input accounts would be needed to cover what we would assume to be the normal functions of financial accounting in regard to these fifteen types of transactions. The input accounts would consist of one for the beginning balance of the cash account, six for the beginning balances of the accounts receivable accounts, and fifteen to accumulate totals for each of the fifteen types of transactions. Itemized, they would be shown in Exhibit 5 on page 49.

Referring back to Exhibit 1, it will be noted that Input 1 would be the equivalent of Accounts 8 through 22, and Input 2 would be equivalent to Accounts 1 through 7. Since the latter accounts are beginning balances of the period, they are at a higher level of abstraction than the fifteen which deal with the transactions of the current period.

How system works

Now, assume we code the current transactions as they take place and process them in a real-time computer system, where the beginning balances are also stored by account code. By using these twenty-two accounts, we could ask for answers to our questions in the following way:

1. If we wanted to know the current cash balance we would ask the computer system to add Accounts 1, 8, 9, 10, 17, 18 19, 20, 21, 22, etc. (the additional increases and decreases in cash our partial system has ignored). Obviously, it would be absurd to operate a manual system in this manner. The amount of detail involved every time a question was asked would cause undue delay and confusion and probably would result in many errors. Obviously, too, it would be absurd even in a computer system to inquire in this manner for answers to routine questions. Instead, a computer program would be prepared which would simplify the process of inquiry. For example, we might simply ask "What is the current cash balance?" and the calculations mentioned above would be completed in a fraction of a second and the answer given to us.

While computer programing would be advisable to obtain the answer to such a routine question, there would still be no need to maintain a separate continuing account in the computer for the current cash balance. The answer can be calculated so quickly by the computer system from the original input accounts that such redundancy is unnecessary. On the basis of this same principle, it is also unnecessary to maintain account balances for the other answers making up the original estimate of one trillion possibilities.[7] The answers to these other possibilities are nevertheless stored in the input accounts waiting for us whenever we need them. The only requirements we must meet to get an answer is first to define our question and then ask it in a manner the computer system can comprehend, e.g., add Accounts 1, 8, 9, 10, 17, 18, 19, 20, 21, 22, etc.

2. Obtaining information about the accounts receivable would also assume computer programing for routine questions. For example, one such question might be as follows: What is the current accounts receivable balance for the company as a whole? The answer would be obtained by the system by adding Accounts 2, 3, 4, 5, 6, 7, 11, 12, 13, 14, 15, 16 and subtracting Accounts 17, 18, 19, 20, 21, 22.

Double entry unnecessary

The use of Accounts 17 through 22 in this particular calculation reveals another important feature of input accounts. These six input accounts, which represent cash collections on various types of accounts receivable, are *subtracted* in the present case where we are calculating the current accounts receivable balance. Previously, in calculating the current cash balance, these same input accounts

EXHIBIT 4

List of Input Transactions

I_1 equals L_1T_1 (location one, sales for cash)
I_2 equals L_2T_1 (location two, sales for cash)
I_3 equals L_3T_1 (location three, sales for cash)
I_4 equals L_1T_2 (location one, sales on 30-day account)
I_5 equals L_2T_2 (location two, sales on 30-day account)
I_6 equals L_3T_2 (location three, sales on 30-day account)
I_7 equals L_1T_3 (location one, sales on 90-day installment)
I_8 equals L_2T_3 (location two, sales on 90-day installment)
I_9 equals L_3T_3 (location three, sales on 90-day installment)
I_{10} equals L_1T_2 (location one, cash collections on 30-day accounts)
I_{11} equals L_2T_2 (location two, cash collections on 30-day accounts)
I_{12} equals L_3T_2 (location three, cash collections on 30-day accounts)
I_{13} equals L_1T_3 (location one, cash collections on 90-day installments)
I_{14} equals L_2T_3 (location two, cash collections on 90-day installments)
I_{15} equals L_3T_3 (location three, cash collections on 90-day installments)

EXHIBIT 5

Input Chart of Accounts

ACCOUNT NO.	ACCOUNT DESCRIPTION
1	Beginning cash balance for the whole company
2	Beginning balance of accounts receivable—30-day accounts—location one
3	Beginning balance of accounts receivable—30-day accounts—location two
4	Beginning balance of accounts receivable—30-day accounts—location three
5	Beginning balance of accounts receivable—90-day installments—location one
6	Beginning balance of accounts receivable—90-day installments—location two
7	Beginning balance of accounts receivable—90-day installments—location three
8	Cash sales—location one
9	Cash sales—location two
10	Cash sales—location three
11	Sales on 30-day account—location one
12	Sales on 30-day account—location two
13	Sales on 30-day account—location three
14	Sales on 90-day installment—location one
15	Sales on 90-day installment—location two
16	Sales on 90-day installment—location three
17	Cash collections—30-day accounts—location one
18	Cash collections—30-day accounts—location two
19	Cash collections—30-day accounts—location three
20	Cash collections—90-day installments—location one
21	Cash collections—90-day installments—location two
22	Cash collections—90-day installments—location three

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[7] We are ignoring the fact that by adding the six beginning balance accounts we have actually increased the number of answers possible.

were *added* in obtaining the new cash balance. In other words, the computer system conceived here does not need to maintain separate double entry accounts with their balancing debits and credits. It can use a single input account balance to denote the amount of a debit in one case, the amount of a credit in another, and the amount to be treated in any other fashion we wish in some other situation. Since the computer does not become confused when faced with numerous highly detailed instructions about each and every input account, the double entry checks and balances that were developed to overcome the limitations of a manual system can be dropped. In fact they must be dropped if the computer is to be allowed to use its full power in taking a single input account and making "innumerable" rather than only "single" or even "double" entry use of it.

The computer system conceived here does not need to maintain separate double entry accounts with their balancing debits and credits. It can use a single input account balance to denote the amount of a debit in one case, the amount of a credit in another, and the amount to be treated in any other fashion we wish in some other situation.

Accounts receivable

Obviously, other routine questions might be asked about the accounts receivable. We might ask for the current accounts receivable balance on:

a. the 30-day accounts (add 2, 3, 4, 11, 12, 13 and subtract 17, 18, 19).

b. the 90-day installment accounts (add 5, 6, 7, 14, 15, 16 and subtract 20, 21, 22).

c. accounts at Location one (add 2, 5, 11, 14 and subtract 17, 20).

d. and so on.

In all of these cases, the answers would be derived by adding and subtracting the appropriate input account balances.[8]

3. If we needed various facts about the current sales activity, we could ask the computer system to provide or combine Accounts 8 through 16 in various ways:

a. The balance in Account 8 is the cash sales for Location One. This balance would provide useful information by itself.

b. By adding Accounts 8, 11, and 14, we would have the total of all sales for Location One. We could ask that these input account balances be given to us in total, separately, or both.

c. By adding Accounts 11, 12, and 13, we would have the total sales on 30-day accounts for the whole company. Again, we could ask for just the total, the supporting account balances, or both.

d. By adding Accounts 8 through 16, we could have the total sales for the company, and/or its supporting details.

e. And so on.

All of these accounts, 8 through 16, have been used before in making calculations of the current cash balance or the current accounts receivable balances. The input account balances may be used over and over again in as many combinations as are needed in the specific applications.

In the above limited examples of the use of input accounts in connection with cash, accounts receivable, and sales, we have confined ourselves to the kind of information usually related to a balance sheet or income statement. From the input account balances we computed some of the output account balances included in balance sheets and income statements and some of the information included in schedules supporting those output balances. We produced all of this information for the balance sheet and income statement by combining the input account balances in various ways. Of course, we do not have to limit ourselves to these two types of statements. We could produce other types of statements by the same advantageous combination of input accounts, e.g., we could prepare a statement of sources and applications of funds.

The advantage of the input method can be further demon-

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[8] *Accounting and The Computer*, American Institute of Certified Public Accountants, Inc., New York, N.Y., 1966, p. 295 (a reprint of A. F. Moravec, "Basic Concepts for Designing a Fundamental Information System," *Management Services*, July-August, 1965, p. 40). Moravec applies the input concept in what he calls the "single information flow concept."

strated by comparing it to the traditional method accountants are taught to use when preparing a statement of sources and applications of funds. The traditional worksheet method starts with the balance sheets for the beginning and the end of some accounting period. (Note that all of the account balances on these balance sheets would be output-oriented.) On the worksheet, the net change in each of the output account balances between the two points in time would be calculated. Then, these net figures would be divided into those that are classified as current accounts and those that are non-current accounts. The net changes in the non-current account balances are the figures that will be used to begin the preparation of the statement of sources and applications of funds.

Funds flow statement

However, the account balances on each of the balance sheets were originally computed to answer one question, i.e., what *is* the financial position of the company at some *given point in time*? The question, "What were the sources and applications of funds between two given points in time?" was not contemplated in the preparation of the balance sheets. Consequently, the calculation of the net changes in the non-current output account balances produces a conglomeration of data which cannot answer the new question. The conglomeration hides within its net totals some information that does apply to the funds flow question and some that does not. From this point on, then, the process is a familiar one to the accountant. He refers to other records, analyzes the net change figures in detail, sifts out what he needs, and excludes what he does *not* need. All of this process is required because the initial information being used comes from an output-oriented system which was never really intended to provide funds flow information. Faced with a question its designers did not preconceive, the output-oriented system can provide an answer, but only in a very inefficient manner.[9]

Sources of funds

Now let us look briefly at how our twenty-two input accounts would be used to prepare a statement of sources and applications of funds. As before, the preparation of the new statement would be accomplished by the simple expedient of combining input accounts in various ways. Since we did not conglomerate the data to answer some preconceived question in the first place, we will not have to engage in any separation or analytical process to make the data useful in serving our new requirements. Accounts 1 through 7 are beginning balances and so cannot be sources or applications of funds in the current period. Accounts 17 through 22 represent the conversion of one type of current asset (accounts receivable) into another type of current asset (cash) and so are neither sources nor applications of funds. Accounts 8 through 16, sales for cash and on account during the current period, are sources of funds and are already in an appropriate form to be used in the preparation of a partial statement of sources and applications of funds. For example:

1. By adding Accounts 8 through 16, etc. (the additional input accounts our partial system has ignored) we could obtain the sources of funds for the company as a whole. From these same accounts we could also obtain a partial statement of sources by location. For instance, Accounts 8, 11, and 14 are sources of funds from Location one; Accounts 9, 12, and 15 are sources from Location two; and Accounts 10, 13, and 16 are sources from Location three.
2. If we had the additional input accounts that would be provided in a complete system, we would apply the same combination procedure to obtain the applications of funds for the company or its separate locations.

It seems readily apparent, even in this admittedly limited example, that an input system would be capable of providing a statement of sources and applications of funds with relative ease, while an output system would require a great amount of special analysis and adjustment.

Concluding comments

Throughout the preceding presentation, we have had to leave much to the reader's imagination in order to provide a concise statement of some of the more important implications an input chart of accounts would have for a computerized accounting system. We wish, however, to outline one additional thought before closing our commentary. Earlier, when discussing the fifteen types of transactions to be used as examples in our partial system, we indicated they could produce fifteen factorial or about one trillion different answers. Strictly speaking, this is merely the number of ways the fifteen input account balances can be arranged in the process of computing output account balances. If we had wished, of course, we could have done much more than simply arrange and compute account balances. For example, we could also have the computer system calculate the ratio each account or combination of accounts is to various totals, compare any of these figures to those of past periods, make projections of future periods based on the activity of the current period, and so forth. In short, since the accounting system we are visualizing here would truly be an information system in every sense of the term, the number of answers such a system could provide is beyond imagination or calculation.

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[9] Butterworth, *op. cit.*, p. 61. Butterworth makes exactly the same point, i.e., accountants experience difficulty in using account balances at the beginning and end of a period to derive a statement of sources and applications of funds.