The TICOM model—A network data base approach to review and evaluation of internal control systems

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ABSTRACT

EDP based accounting information systems have grown in complexity and size. This growth has partially been the result of new and advanced software techniques introduced by computer scientists. This paper is one in a series of papers which provide a new perspective for auditors of EDP based AIS’s facilitated by new software development methodologies which address development of “reliable” software systems. In another paper we asserted reliable software would eliminate the need to verify computer programs except for an authenticity check; thus, facilitating a more thorough examination of the total internal control system. We describe a model which facilitates review and evaluation of internal control systems from a “total” systems perspective.

INTRODUCTION

In earlier papers, we surveyed the extant literature on verification techniques for EDP based accounting information systems (AIS), and presented a methodology that facilitates the development of reliable AIS software systems. In the second paper, we asserted that reliable software would eliminate the need to verify computer programs except for an authenticity check; thus, facilitating a more thorough examination of the total internal control system. This paper describes a model which facilitates review and evaluation of internal control systems from a “total” systems perspective. The model can be applied to any existing AIS and will contribute significantly to the auditor’s comprehension and testing of the AIS. However, its greatest potential impact is in its application to reliable AIS. The fourth paper in this series presents the detailed development of the TICOM model presented in this paper.

INTERNAL CONTROL OVERVIEW

Auditing objectives have changed over time. R. Gene Brown traced this evolution as shown in Figure 1.

<table>
<thead>
<tr>
<th>Period</th>
<th>Auditing Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>1500-1850</td>
<td>Detection of fraud</td>
</tr>
<tr>
<td>1850-1905</td>
<td>Detection of fraud and clerical errors</td>
</tr>
<tr>
<td>1905-1940</td>
<td>Detection of fraud and clerical errors; determination of fairness in reporting</td>
</tr>
<tr>
<td>1940</td>
<td>Present determination of fairness in reporting</td>
</tr>
</tbody>
</table>

Figure 1—Evolution of auditing objectives

Implicit in each of these objectives was the method and extent of system evaluation and verification. Fitzpatrick states that during the sixteenth century, when auditing existed specifically to verify the honesty of persons charged with fiscal responsibilities, the extent of verification was very detailed, while evaluation of internal control was not considered a relevant function in performing audit objectives. Currently, substantial emphasis is placed on evaluation of internal control as a means of determining the scope and extent of verification. This emphasis is reflected in the second standard of field work included in the ten generally accepted auditing standards:

There is to be a proper study and evaluation of the existing internal control as a basis for reliance thereon and for the determination of the resultant extent of the tests to which auditing procedures are to be restricted.

As explicit as this statement is on a general level, very few aids exist to help the auditor make objective statements and judgments about a specific internal control system at the overall level. Numerous articles exist using statistical techniques to make statistically objective statements concerning the internal control system. However, the state-
ments made are related to very specific and limited issues within the system and nothing is said about the system at a more general level.

Numerous professional statements can be found which suggest that this is an area requiring the highest degree of judgment and professional experience. Though we believe no audit tool will or should completely remove professional judgment from this function, most researchers continue to fail in the development of a general model with which the auditor can ask for and receive objective evidence about his client's internal control system. Bodnar,5 Ishikawa,6 Yu and Neter,7 and Cushing8 are researchers who provided models which addressed this objective, formal evaluation problem, but did not provide a facile means of interface with the models. Other writers have suggested effective subjective means of exploring a system for strengths and weaknesses, but do not provide straightforward criteria for decisions about the system. The work contained herein addresses several important issues:

(a) provides an encoding mechanism for internal control systems that views automated and manual procedures equally which provides a total systems perspective for review and evaluation.
(b) uses recent EDP technological advances to facilitate review and evaluation of the system which provides for more thorough investigation.
(c) facilitates positional analysis.
(d) eliminates "slanted" questions on a questionnaire.
(e) allows simulation of accounting subsystems to check for "lagged" (also termed "compensatory") control procedures, and subsystem overlap that might condone fraudulent activity.
(f) facilitates viewing internal control systems at different levels of detail which allows the auditor to specify the level of detail needed to perform the review and evaluation.

CHARACTERISTICS OF INTERNAL CONTROL

Internal controls are organizational arrangements and the actions instituted under such arrangements taken within an organization to direct and regulate activities of that organization. Both management and auditors have recognized the potential benefits of effective internal control. More specifically, auditors have realized that improved internal control "... permits reductions in audit work made possible by the concomitant increase in the credibility of accounting records. (In fact, it may be argued that without a minimum level of internal control an audit on the fairness of financial statements would not be possible.) The effect on auditing has thus been to reduce the need for routine, mechanical verification of bookkeeping accuracy, permitting substitution of a less time consuming approach that involves reasoning and judgment and stresses such activities as review, analysis, evaluation, and statistical sampling."

Obviously, if the auditor limits the scope of his examination based on the reliability of his client's internal control system, he must have sufficient basis for formulating an opinion on the effectiveness of the system. This implies he should be aware of some basic characteristics of good internal control.

Numerous methods and techniques exist for achieving good internal control. SAS1 indicates that the methods should minimally include the following characteristics:

(a) a plan of organization which provides appropriate segregation of functional responsibilities;
(b) a system of authorization and record procedures adequate to provide reasonable accounting control over assets, liabilities, revenues, and expenses;
(c) sound practices to be followed in performance of duties and functions of each of the organizational departments;
(d) personnel of a quality commensurate with responsibilities.

The first characteristic addresses the concept of division of duties. That is, no one department (or person) should be responsible for handling all phases of a transaction. Another way of looking at this characteristic is that no department (or person) should control the accounting records relating to its own operation.

The second characteristic concerns checks and proofs of accuracy and authorization. Although not explicitly stated, this characteristic also involves procedures for error checking and correction. That is, "reasonable accounting control" must involve procedures for investigating and correcting errors when they occur.

Characteristics three and four are requirements of any efficient organization and are redundant when applied to internal control within an organization. However, the "reliability" of a specific internal control system cannot be assessed without contextual evaluation of these characteristics.

More specifically, one must adopt a perspective for examining an internal control system which highlights the basic characteristics mentioned. Such a perspective is presented in the next section.

INTERNAL CONTROL PERSPECTIVE

The most prudent classificatory technique for identifying internal control is to distinguish between characteristics that constitute controls and activities subject to control. This classification scheme facilitates use of the traditional control matrix for logical analysis of these systems. Figure 2 illustrates this perspective. The internal control primitives to be presented later can be thought of as activities subject to control. Control characteristics are subdivided into three types: preventive, detective, and corrective. Within each of these types, detail features may be encoded. Every public accounting firm has a list of features it considers prudent for their objectives. Therefore, we do not provide an exhaustive list. The fact that TICOM addresses this issue is
Characteristics That Constitute Controls

<table>
<thead>
<tr>
<th>Preventive</th>
<th>Detective</th>
<th>Corrective</th>
</tr>
</thead>
<tbody>
<tr>
<td>INITIALIZE</td>
<td>CREATE OBJECT</td>
<td>RECORD</td>
</tr>
<tr>
<td>PROOF</td>
<td>CONTROL</td>
<td>COMPARE</td>
</tr>
<tr>
<td>TRANSFER</td>
<td>AUTHORIZE</td>
<td>STORE</td>
</tr>
<tr>
<td>MERGE</td>
<td>EJECT</td>
<td>HALT</td>
</tr>
<tr>
<td>SORT</td>
<td>UPDATE</td>
<td>INTERNAL</td>
</tr>
</tbody>
</table>

Figure 2—Internal control perspective

the point we want to emphasize. Example detail features are shown in Figure 3.

This perspective can be further expanded by considering different contextual areas within an internal control system. For example, computerized phases of the system have been characterized in terms of three areas:

(a) Application controls—unique to individual subprocesses of this system
(b) Information Processing Facility (IPF)—which affect the computer installation and environment, and how most applications are processed in a facility
(c) Systems Management controls—which assure design, implementation and maintenance are performed in a prudent, secure, and systematic manner.

The crux of this matter is the flexibility afforded by the model to allow different public accounting firms to view the system within their own perspective.

PROBLEM STATEMENT

According to Stettler, there are three basic, closely related questions, that provide a basis for the auditor’s conclusion on internal control:

(a) What are the purported internal control procedures?
(b) Are those procedures being followed?
(c) How satisfactory are those procedures?

Currently, these questions are addressed by the auditor in obtaining and storing information about the organization, in such a way that provides a comprehensive picture of the organization. Questionnaires and system flow-charts are currently used, and are stored in a “permanent audit file” for the given client. Although such methods are flexible, and widely accepted, we argue that many key issues of internal control are not properly addressed by these techniques because of the sequential and segmented nature of elicitation, storage, and retrieval of the relevant data.

For example, because each of the accounting subsystems (e.g., accounts payables, cash receipts, accounts receivables) is explored individually and often in some sequence, the common points of two subsystems that might condone fraudulent activity could easily be overlooked. Likewise, employees who perform logically different functions, but whose physical work areas permit access to logically unauthorized functions may not be discovered. The classic example of the need for positional analysis is illustrated by Mautz and Mini and summarized below:

Suppose we have a questionnaire with the following questions:

1. Is the handling of customer remittances separated from the recording of such remittances in the cash receipts journal and accounts receivable subsidiary ledger?
2. Is a pre-listing of mail receipts prepared?
3. Is this list compared with cash book entries?

Assuming these questions were answered “no,” “yes,” and “yes” respectively, it is impossible to determine if the described conditions constitute a vulnerable point in the system. If, for example, the person handling and recording customer remittances was the same person working with the pre-list of mail receipts or had access to the pre-list, vulnerability is high.

It is obvious that the questionnaire could be recon-
constructed to expose this weakness; however, as will be illustrated later, the network approach presented herein for describing a system forces the inclusion of positional analysis inquiries on a questionnaire.

Another issue worthy of comment centers on "lagged" or compensatory control procedures. These terms refer to control procedures that offset or counteract an action elsewhere in the system; which if evaluated singly would be construed as a weakness in the internal control system. An example would be a cash receipts system in which a cashier received cash payments from customers and was charged with making the accounting entry that reflected receipt of the cash, and the customer was not given a receipt slip of any kind. In such a system the cashier could "pocket" the cash and omit making the accounting entry with no mechanism to provide a signal indicating improper action. Now, if we added to the above description that the customer leaves the cashier and goes to another window to record the cash payment (the customer cannot leave the system without doing this), we have added a control feature which appears after an action that possesses undesirable control characteristics. This type of analysis is facilitated by simulation of the control system. Thus, simulation would seem to be an essential part of a mechanism to evaluate an internal control system.

It is easily deduced that this discussion of issues could continue over numerous pages. The key point is that a model is needed which ameliorates the auditor's review function with respect to internal control systems. This can only be accomplished by adoption of the aforementioned total system approach made possible by recent advances in data management systems and interfaces. Decreasing costs for computer hardware, increased capability of software to handle complex data structures, and increased complexity of constituent parts of control systems (for example program logic) have all contributed to motivate expanded use of computerized information systems. This effort is another which views that continued expansion as imminent.

Stated formally, the objective of this work is to define a facile means for formally describing and objectively evaluating an internal control system. The proposed mechanism should have the capacity to organize and retrieve data about the system in a manner that permits the auditor to objectively address the issues listed earlier. Such a mechanism will facilitate more thorough examination of these systems.

**TICOM OVERVIEW**

Figure 4 depicts schematically an overview of the proposed system. After initialization, the auditor elicits information about the organization and records this information in the "Internal Control Description Language." The ICDL is submitted to the "Internal Control Description Language Analyzer" (ICDLA) which checks for inconsistencies and other errors in the ICDL. If no problems or errors are discovered by the ICDLA then the data is loaded onto the "Internal Control Description Data Base" ICDB. Figure 5 depicts a simplified version of ICDB. At this point the auditor is able to make queries of the data base. Each of these steps in the TICOM cycle is described in the following sections.

While examining the material that follows, remember that our main purpose in developing this model was to provide the auditor with aids for more objective evaluation of internal control than currently available to him.

**Initialization**

The first step in the TICOM cycle is setting up the static and literal information in the internal control system. We
will explain the use of this information later. For now we provide an outline of the order of events in this step, list the information required at this point, give a short description of its use, and illustrate in Figures 6 and 7 forms for recording the data. (It should be noted that the information requested in this step does not require the physical presence of an auditor. This data can be gathered and submitted via mail carrier before the elicitation step):

I. Request Allocation of EDP Equipment (Client's or Firm's)
   A. Auxiliary storage allocation
   B. CPU time allocation
Organization Description Worksheet - I

Name of Client: Qube Drugs #1

Date: July 5, 1976

<table>
<thead>
<tr>
<th>TITLE</th>
<th>EMPLOYEE</th>
<th>EMPLOYEE'S</th>
<th>EMPLOYEE'S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description ID</td>
<td>Description ID</td>
<td>Functional Loc. ID</td>
<td>Physical Loc. ID</td>
</tr>
<tr>
<td>Store Mgr.</td>
<td>Bob Stern</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Cashier</td>
<td>Linda Itt</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Cashier</td>
<td>Jus Cunn</td>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>

Organization Description Worksheet - II

Name of Client: Qube Drugs #1

Date: July 5, 1976

<table>
<thead>
<tr>
<th>FUNCTIONAL LOCATION</th>
<th>PHYSICAL LOCATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description ID</td>
<td>Description ID</td>
</tr>
<tr>
<td>Store Office</td>
<td>Pharmacy Counter</td>
</tr>
<tr>
<td>Cashier's Window</td>
<td>Bus. Off. Rm 43</td>
</tr>
<tr>
<td>Sales Window</td>
<td>Bus. Off. Rm 1</td>
</tr>
</tbody>
</table>

Figure 7—Sample completed forms for recording static and literal data

C. Programs for TICOM
   1. ICDLA
   2. Query Processor
   3. etc.

II. Obtain Static and Literal Data

A. Use forms similar to those in Figures 6 and 7 to collect this data.

B. Data can be loaded as a part of hardware initialization for this client.

C. Required Information (Example)
   1. TITLE—names of positions similar to those found on company organization charts.
   2. EMPLOYEE—names of persons who the relevant position. Note that if two employees have the same job title but different authorization responsibilities we should have no problem
differentiating between the two via the employee identification code.

3. FUNCTIONAL LOCATION—to facilitate the previously mentioned positional analysis.

4. PHYSICAL LOCATION—for those firms that segregate employees by logical accounting functions.

5. IDENTIFICATION—from the standpoint of implementation, it may be desirable to index or tag this information rather than use literal descriptions.

Elicitation procedure

There are two approaches one could take for evoking a description of the internal control system: questionnaire and free-form.

Free-form is equivalent to the process a programmer follows in writing code. The first step is to outline the logic for the algorithm to be coded; and next to specify instructions in the given language which corresponds to that logic. The analogue of that procedure is an auditor developing a mental image of the internal control system and transposing that image into the descriptive language presented later. Proponents of this approach argue that a descriptive language such as the one we propose which uses terms familiar to the auditor will require no more technical proficiency than the use of flow-charts when they were first introduced.

Proponents of the questionnaire approach argue if the proposed model is to possess attributes which imply current applicability and practicality, the elicitation procedure should be kept as close as possible to current practice while capturing the information required for the data base. We have chosen to use the questionnaire approach for illustration of basic concepts for this model. Figure 8 illustrates a sample elicitation form and serves as an introduction to primitives of ICDL.

The first thing to note about the questionnaire is the elimination of "nailed" questions. That is, the traditional wording of a questionnaire such that "NO" answers suggest undesirable practice relative to achieving good internal control. Behavioral implications of such questionnaires are not in the scope of this work but are definitely noteworthy. Our questionnaire elicits description without involved evaluation thus separating the two activities.

The function listed below each question is the ICDL primitive that corresponds to the question being asked. Note that the auditor should not have to reproduce these primitives since they are preprinted on the form and imply the initial level of detail required by the auditing firm. The auditor is required to fill in the arguments of the primitives based on the response made and a list of coded alternatives. Figures 9 and 10 list ICDL primitives and sample argument alternatives. We do not propose that the given primitives are an exclusive or totally comprehensive set, but that they serve to illustrate the desirable level of detail and flexibility of this model. Clearly, each public accounting firm may view the organization as based on different sets of primitives, and that should not cause any problem with the application of this model. The key issue is storage of a machine readable version of the system, at arbitrary levels of detail, for more thorough investigation of its possible strengths and weaknesses.

The column labeled "STEP" is used to form an index for the sequence of execution and level of detail of the relevant primitives.

Once the questionnaire has been completed, the auditor would submit it to the firm's (or the client's) EDP personnel for conversion into machine readable form and input to the ICDLA. Example execution of this next step in the TICOM cycle is given in the next section.

Generation of internal control description language

The primitives that appear on the questionnaire (or free-form, if that approach is chosen) next serve as input to the ICDLA. This step is performed by keying responses into machine readable form. A special header record would probably be used to delimit subsystems. An example of the information that might be submitted, which corresponds to each ICDL statement, is:

(a) Primitive name
(b) Primitive arguments
(c) Step
(d) Related employee or title id's
Example: \[
\text{INITIALIZE (STIMULI-TYPE, CONTENT, SOURCE, DESTINATION, CARRIER CONTROL-ATTRIBUTE, ATTRIBUTE-DETAIL)}
\]
\[
\text{IN}(a_1, a_2, a_3, a_4, a_5, a_6) \quad \text{An action or event that causes execution of a subsystem (e.g., receipt of a payment on account via the mail invokes the cash receipts subsystem)}
\]

\[
\text{CREATE OBJECT (LITERAL-DESCRIPTION, CONTROL-ATTRIBUTE, ATTRIBUTE-DETAIL)}
\]
\[
\text{CO}(a_7, a_8, a_9) \quad \text{The generation of paper as a result of, or to record asset flow (e.g., the generation of a receipt to record acceptance of cash)}
\]

\[
\text{RECORD (LITERAL-DESCRIPTION, SOURCE, DESTINATION, CONTROL-ATTRIBUTE, ATTRIBUTE-DETAIL)}
\]
\[
\text{RD}(a_{10}, a_{11}, a_{12}) \quad \text{The documentation of an asset (e.g., recording cash and checks in a cash receipts book or accounts receivable (control account)}
\]

\[
\text{PROOF (LITERAL-DESCRIPTION, MECHANICAL-DEVICE, CONTENT, CONTROL-DOCUMENT, NEXT-STEP, CONTROL-ATTRIBUTE, ATTRIBUTE-DETAIL)}
\]
\[
\text{PR}(a_1, a_2, a_3, a_4, a_5, a_6) \quad \text{A control or check point at which a mechanical device generates a control item (e.g., a cash register's receipts total)}
\]

\[
\text{CONTROL (LITERAL-DESCRIPTION, CONTROL-DOCUMENT, CONTROL-DOCUMENT, NEXT-STEP, CONTROL-ATTRIBUTE, ATTRIBUTE-DETAIL)}
\]
\[
\text{CT}(a_1, a_2, a_3, a_4, a_5) \quad \text{A check for offsetting paperwork entries}
\]

\[
\text{COMPARE (LITERAL-DESCRIPTION, MECHANICAL-DEVICE, MECHANICAL-DEVICE, NEXT-STEP, CONTROL-ATTRIBUTE, ATTRIBUTE-DETAIL)}
\]
\[
\text{CM}(a_1, a_2, a_3, a_4, a_5) \quad \text{A completely mechanical control point or check (e.g., the hardwired checks between two cash registers)}
\]

\[
\text{TRANSFER (LITERAL-DESCRIPTION, CONTENT, SOURCE, DESTINATION, CARRIER, CONTROL-ATTRIBUTE, ATTRIBUTE-DETAIL)}
\]
\[
\text{TR}(a_1, a_2, a_3, a_4, a_5, a_6) \quad \text{Physical movement of an asset or paperwork (e.g., movement of checks from the mailroom to the cashier's office)}
\]

\[
\text{AUTHORIZE (LITERAL-DESCRIPTION, CONTENT, AUTHORIZATION-METHOD, AUTHORIZER, CONTROL-ATTRIBUTE, ATTRIBUTE-DETAIL)}
\]
\[
\text{AR}(a_1, a_2, a_3, a_4, a_5, a_6) \quad \text{This primitive encodes the points of authorization in the internal control system}
\]

\[
\text{STORE (LITERAL-DESCRIPTION, CONTENT, SOURCE, DESTINATION, CARRIER, CONTROL-ATTRIBUTE, ATTRIBUTE-DETAIL)}
\]
\[
\text{ST}(a_1, a_2, a_3, a_4, a_5, a_6) \quad \text{The transfer of an item to a quasi-final or normal place of residence (e.g., cash deposited in a bank)}
\]

\[
\text{MERGE (LITERAL-DESCRIPTION, LITERAL-DESCRIPTION, LITERAL-DESCRIPTION, CONTENT, CONTROL-ATTRIBUTE, ATTRIBUTE-DETAIL)}
\]
\[
\text{MG}(a_1, a_2, a_3, a_4, a_5, a_6) \quad \text{A description of the merger of two items into one. This combination will continue through the system as one item (e.g., the combination of day's receipts of cash and checks into cash receipts)}
\]

\[
\text{EJECT (LITERAL-DESCRIPTION, LITERAL-DESCRIPTION, LITERAL-DESCRIPTION, CONTROL-ATTRIBUTE, ATTRIBUTE-DETAIL)}
\]
\[
\text{EJ}(a_1, a_2, a_3, a_4, a_5, a_6) \quad \text{The emission of items out of the internal control system (e.g., finished goods that were sold and carried away by the customer)}
\]

\[
\text{SORT (LITERAL-DESCRIPTION, CONTENT, CONTROL-ATTRIBUTE, ATTRIBUTE-DETAIL)}
\]
\[
\text{ST}(a_1, a_2, a_3, a_4) \quad \text{A description of item rearrangement}
\]

\[
\text{UPDATE (LITERAL-DESCRIPTION, LITERAL-DESCRIPTION, OPERATOR, RESULT, CONTROL-ATTRIBUTE, ATTRIBUTE-DETAIL)}
\]
\[
\text{UP}(a_1, a_2, a_3, a_4, a_5, a_6) \quad \text{Item modification, such as accumulation of data values or information}
\]

\[
\text{INTERVAL (PERIOD, CONTROL-ATTRIBUTE, ATTRIBUTE-DETAIL)}
\]
\[
\text{IV}(a_1, a_2, a_3, a_4) \quad \text{Primitive to facilitate time intervals between adjoining primitives}
\]

\[
\text{HALT (SUBSYSTEM)}
\]
\[
\text{HT}(a_1) \quad \text{The end of primitives related to this subsystem}
\]

Free-form would require encoding of this data. In the example above, the INITIALIZE primitive is encoded. Referring to Figures 9 and 10 we are able to decode the primitive (b) as follows:

1. The first parameter, 1, corresponds to \(a_1\), of the IN specification given in 9. As shown, it specifies the STIMULI-TYPE. Examination of 10 reveals that 1
denotes EXTERNAL stimuli were responsible for initialization of this subsystem. An example of this type of stimulus is a customer making a payment on account and invoking the accounts receivable system. This is contrasted with an employee submitting a time card and initiating the payroll system; which we term INTERNAL stimulus.

2. The second parameter indicates the CONTENT parameter denotes ASSET, with CASH being the particular type of asset.

3. The SOURCE parameter denotes CUSTOMER.

4. DESTINATION is the FUNCTIONAL AREA described as FINISHED GOODS AND SERVICE.

5. The CARRIER in this example is CUSTOMER.

6. The CONTROL-ATTRIBUTE is not applicable in this instance.

7. As a result of 6, ATTRIBUTE-DETAIL is not applicable.

Components (c) and (d) of the example specify sequence and related employees. The "step" parameter defines this ICDL statement to be the first for the given subsystem. The employee numbers (id) identify employees related to the statement that are not explicitly included via the EMPLOYEE-FUNCTION-FUNCTION LOCATION relationship.

This example facilitated the introduction of several issues concerning the language. First, we are able to differentiate between asset and paperflow movement through the system. Second, the high degree of parameterization in this system facilitates the extreme flexibility and adaptability we eluded to in earlier sections. Next, the encoding of control objectives via parameters a14 and a15, allows the auditor to explicitly identify and label these features (this point will be discussed further below). The indexing illustrated, such as 1.1 and 2.1 for a2 and a4 respectively, facilitates the aforementioned "levels of detail" when applied to STEP.
Internal control description language analyzer

This process is the main link between the auditor and a description of the given internal control system stored in a network data base structure. The inherent tasks of any analyzer are also in evidence here. That is, the logical analysis of a model of any information system includes determination of consistency and completeness of the model. Consistency implies the system follows a design determined by propositional statements of definitions and relations. When these statements are applied to the model, inconsistencies are detected. Completeness is a consistency concern which involves the unique resolution of given relations. We will omit detailed explanation of this process since there exists a substantial body of literature on this topic. More pertinent are its tasks related to generating the target data base (Figure 11). Omitting the obvious tasks of any analyzer, we assume it sufficient to say appropriate diagnostics would be printed.

The major task of the analyzer is the generalized load function it must perform. Figure 12 schematically outlines this procedure. Each subsystem will be denoted by the aforementioned header record. When a new subsystem is encountered the analyzer first checks that the subsystem just finished ended with the proper primitives (HALT). It then creates (or allocates) a record occurrence corresponding to the record type that denotes “SUBSYSTEM.” The next ICDL statement is read and its type is determined. If it is a primitive, the associated record type is created, linked to the other primitives, relevant data items stored, and finally, the next statement is read. If it was a HALT statement, subsystem “housekeeping” is performed, or the next statement is read.

Internal control description data base

Figure 13 schematically depicts a schema which would support query access to such a system. In this organization the primitive-type would be encoded in the record occurrence with the other static information given as shown. Details of this structure are the topic of another paper.

However, we will provide a few comments to make the structure comprehensible.

The LINK records that are shown in the figure are included to facilitate many-to-many relationships between the adjoined entities. This is a restriction imposed by the network data base structure we are using. For example, since a given function such as dating incoming mail may be encoded as a step in numerous subsystems by several employees at different locations, it is impossible to establish a one-to-many relationship between FUNCTION and LOCATION as dictated by the network data base implementation requirements. Therefore an intermediate record is introduced to facilitate this relationship.

The HUB record denotes the occurrence of primitives in this structure which highlight information and data flow through the internal control system. The relationship between this record-type and LEVEL facilitates the different levels of detail that can be stored via this structure.

LINK-3 is included specifically to provide quick retrieval of employee names and their functional and physical locations.
The proposed system could be implemented by the GPLAN [Bonczek, et al., 1975] data management facility. In this case the associated query processor would be used by the auditor to access the internal control description stored in the database. The GPLAN query language 13,14 and automatic path determinator 15 would extricate the auditor from developing interfacing programs with the database. That is, the auditor is not required to be a programmer to access this database. Sample queries that the auditor might submit are:

(a) SIMULATE SUBSYSTEM = 'CASH SALES,' LISTING ALL EMPLOYEES FOR PRIMITIVE = 'AUTHORIZE'
(b) LIST THE NEXT PRIMITIVE FOLLOWING PRIMITIVE = 'TRANSFER' FOR CONTENT = 'ASSET'
(c) LIST COMMON EMPLOYEES FOR SUBSYSTEM = 'CASH SALES' AND SUBSYSTEM = 'CASH DISBURSEMENTS'
(d) LIST ALL SUBSYSTEMS FOR EMPLOYEE = 'JOHN GREEN'
(e) FOR PRIMITIVE = 'AUTHORIZE' LIST ALL OCCURRENCES

Upon receipt of a command the query system analyzes the request, sets up the necessary DML commands, executes those commands, and provides the user with the requested information.

EXAMPLE FREE-FORM ENCODING

Before providing detail development of the ICDDDB structure, an example of primitive encoding is presented. In this instance we will take a well-known description of an accounting subsystem and present that system as it may have been encoded using the free-form approach.

Stettler 9 , pp. 274-278 and the AICPA depict accounting subsystems in procedural flowchart form. One of the subsystems they depict is CASH-RECEIPTS. We first provide a literal description of the initial phase of that system and list the corresponding primitive description in Figure 14. Note that only primitives and STEP have been listed; other static information would not aid in this presentation and have been omitted.

Customer initializes the CASH RECEIPTS system by making a cash purchase. A sales slip (2-part) is prepared by a customer service employee in the Finished Goods and Service Department. One part of the sales slip is transferred to the Billing Department of the Controller's office. The other part is carried by the customer to the cashier's window. The cashier accepts the customer's cash and keys relevant information into a cash register. The cash register generates a receipt that is given to the customer. The customer returns to the customer service area and presents the receipt. The relevant goods are given to the customer and they both exit the system.

SUMMARY

This paper was designed to provide a general overview and justification for the use of a network data base to facilitate the auditor's review and evaluation of internal control systems. It is the third in a series of four papers which present a new methodology for auditing of advanced EDP based accounting information systems. A facile means for

<table>
<thead>
<tr>
<th>STEP</th>
<th>PRIMITIVES &amp; ARGUMENTS</th>
</tr>
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<tr>
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<tr>
<td>2</td>
<td>CO (2, 2, 2, 10)</td>
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<td>3</td>
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<td>5</td>
<td>TR (1, 1, 1, 3, 2, 3, 0, 0)</td>
</tr>
<tr>
<td>6</td>
<td>RD (1, 1, 4, 2, 9)</td>
</tr>
<tr>
<td>7</td>
<td>CO (3, 1, 9)</td>
</tr>
<tr>
<td>8</td>
<td>TR (3, 2, 3, 1, 4, 1, 1)</td>
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<tr>
<td>9</td>
<td>TR (3, 2, 1, 2, 1, 3)</td>
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<td>10</td>
<td>AR (4, 1, 2, 3, 1, 1, 1)</td>
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<tr>
<td>11</td>
<td>RJ (5, 1, 2, 3, 1, 3, 0, 0)</td>
</tr>
<tr>
<td>12</td>
<td>HT (3)</td>
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Figure 14—Free form encoding of literal description
formally describing and objectively evaluating an internal control system was presented. The mechanism was presented to have the capacity to organize and retrieve data about the system in a manner that permits auditors to objectively address issues listed in the INTERNAL CONTROL OVERVIEW section of this paper.

The next and last paper of this series will provide technical details of the TICOM model.

REFERENCES