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A Simultaneous-Parallel Approach To Testing Computerized Systems

The co-authors believe that traditional audit methods will not suffice for auditing computerized systems. They have, therefore, developed a new methodology for evaluating both the internal controls and system performance of large, complex computerized systems.

In the past auditors have used many methods to evaluate computerized systems. Their objective was to see whether the systems were operating in accordance with design specifications and applicable policies and procedures. The methods used gave the auditor the ability to evaluate specific aspects of computerized systems (input controls, programing controls, output controls, or system performance), but seldom was the entire system reviewed, at one time, unless the auditor integrated a test facility into the system's design.

To add an integrated test facility to an ongoing system apparently has required almost an entire redesign of the system. However, we have developed a methodology (the simultaneous-parallel approach to an integrated test facility) for testing both the internal controls and performance of an entire comput-

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erized system, even though that system has been operational for several years.

But why all this interest in testing computer systems anyway? Well, in recent years, computer systems have gone from simple punched card input systems to highly complex on-line systems. Also, more systems are interfacing, or electronically exchanging data. In the future, use of on-line systems and real-time updating of master files will increase. As systems become increasingly complex, the independent auditor will be called upon more and more to insure that systems are functioning properly.

This means that the independent auditor will have to play a larger role in system design to make sure that proper controls and audit trails are built into the system. He will have to be highly proficient in data retrieval and analysis techniques so he can evaluate the information accumulated on the computer files. He must be able to (1) test the computerized system's internal controls, since manual controls are being incorporated into the systems, and (2) evaluate the computerized system's performance, since the speed and reliability of output is becoming increasingly important. Techniques like the integrated test facility and our simultaneous-parallel approach should be helpful in evaluating internal controls and system performance.

Definition of Terms

It might be best at this point to define what is meant by internal controls and performance of a computer system.

Internal controls, as defined by AICPA, are those functions which assure the independent auditor that errors and irregularities are discovered with reasonable promptness, thus assuring the reliability and integrity of financial records.[1] In other words, internal controls are those checks and balances that tell the auditor that errors have not occurred in processing, that all records have been accounted for, and that irregularities, such as bad data, cannot enter the system.

System performance, as we define it, is how responsive a computer system is to its user. By this we mean: Does the system provide output reports promptly? Are output reports useful? Does the system lose data during data transmission? Does the system provide enough time for corrective action?

By evaluating these two areas together, the auditor can draw conclusions and make specific recommendations for improving system controls and performance.

Previous Approaches To Computer System Audits

As we mentioned earlier, auditors have used several different methods to evaluate computerized systems. The pros and cons of each follow.

Auditing Around the Computer

Auditing around the computer is probably the cheapest, easiest, and most widely used approach for auditing computerized systems, but to us it is the least effective method because it ignores the "big black box"—the computer. Reconciling input documents to output reports (and vice versa) informs the auditor of nothing more than the fact

[1] *Auditing Standards and Procedures*, American Institute of Certified Public Accountants, 1963, p. 32.

that information sent through the computer system came back in a particular manner. But suppose that transactions are rejected by the system? Why were they rejected? What happened to them after they were rejected? These and many other questions cannot be answered when auditing around the computer.

Auditing around the computer does not address internal controls such as edit checks, limit checks, etc., unless a particular transaction being monitored has an irregularity. Dreaming up possible conditions of errors is not normally done by the initiator of a transaction. However, the auditor should do this because, by monitoring only the normal transactions running through a system, the auditor cannot be sure that all errors or irregularities can and are being discovered.

Furthermore, suppose an output document is not received for a particular input. How can auditing around the computer identify where the data was lost? It can't! Not knowing where the data was lost certainly decreases the chances of improving the system. Also, if there are delays in processing transactions, auditing around the computer will not point out where the bottlenecks are, only that they exist.

It is for these reasons that auditing around the computer is now only part of a computer system audit.

Parallel Test Decking

The next major audit approach is parallel test decking. A test deck is a set of simulated transactions designed to test for the existence and effectiveness of programed controls and procedural operations in computerized systems. Tests should be made up of both normal and irregular conditions, with expected test results already calculated. These tests should show how proper transactions are processed and how improper transactions are identified and rejected from further processing. Actual results from the tests should be compared to the expected results so that deficiencies in processing can be noted and appropriate improvements made.

Test decks are very good for evaluating batch processing systems and can be designed to thoroughly evaluate the computer programs making up the system. However, traditional test decking does not allow the auditor to test the performance of a computer system because the test decks are normally processed parallel, in a separate processing run requiring that computer resources and personnel be specifically assigned. With systems that process around-the-clock, it becomes even more difficult to schedule the test run. Furthermore, with on-line systems, test decks become progressively more difficult to design and process because the input format is sometimes difficult to simulate in a test mode and front-end programs may have to be modified for the special run.

Because parallel test decking does not address system performance, the auditor cannot be sure that the users of the computerized system are receiving useful data promptly. Likewise, bottlenecks in processing cannot always be seen because the volume of system traffic during the parallel test is normally lower, and ADP operations personnel take special care in processing the "auditor's run." Therefore, parallel test decking becomes another part of a computer system audit. Actual observation of computer system processing and

some monitoring of system traffic can be added to the audit scope, but analysis of total performance at one period of time—from initiation of the transaction to final system output—is still difficult to achieve with this method.

Integrated Test Facility

The latest approach to computer system audits is the integrated test facility. This technique allows the auditor to enter test transactions into the system together with regular, live transactions. The auditor then compares the outputs with his expected results (like parallel test decking), so he can verify processing accuracy. He can also evaluate the system's performance by monitoring his test transactions as they process through the system. Master files contain both live and test records and the auditor can retrieve his information for detailed review, using data retrieval and analysis techniques. Bottlenecks and loss of records can be noted by observing and analyzing the flow of information to the master or intermediate files.

With integrated test facilities, however, special care has to be taken to adjust critical outputs, such as accounting reports. In systems which make direct payments to banks or produce checks, "blockages" must be inserted to keep test payments from being made. These adjustments of critical outputs normally mandate that the integrated test facility be built into the system as it is being designed.

However, auditors are not as involved as they should be in system design; therefore, test facilities are not being integrated into systems. To try to develop a test facility after the system is operational and insert the appropriate controls and "blockages" means almost total redesign of the system. Therefore, the integrated test facility, although the most thorough method for evaluating internal controls and performance, is the least used, and may not always be practical.

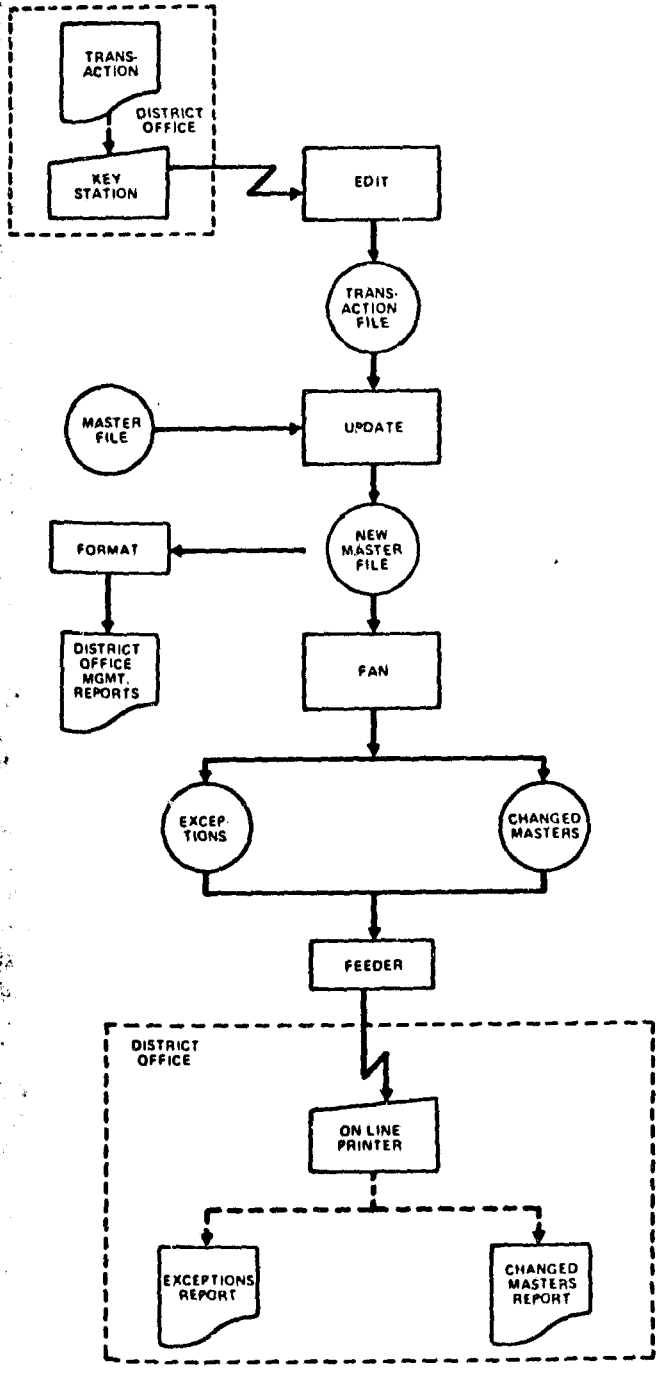
The Simultaneous-Parallel Approach

What we have devised to solve these problems is a combination of the previous approaches—auditing around the computer, parallel test decking, and the integrated test facility. Our approach is especially applicable to on-line systems and can be used with systems both in the design stage and those that have been operating for a period of time. We have labeled our methodology the simultaneous-parallel approach—simultaneous since test transactions are entered into the system at the same time as live transactions, and parallel because, once in the system, test transactions are processed separately until the final output phase, where they are merged with live data for on-line transmission back to the initiator. Our approach requires little program modification, relying mainly on the job control language of the operating system, and two new programs—splitting test from live transactions and merging them back together again. All of this sounds ominous, but in reality these are minor changes to the computerized system.

Let's first look at a very simplified management information system. Figure 1 will be used for discussion purposes.

As you can see in Figure 1, transactions are keyed from district offices

FIGURE 1



through an on-line EDIT program to a magnetic tape. This tape is subsequently batch processed through an UPDATE program which matches the transactions to the appropriate master record, making a new master file for the next system cycle. The new master file is then entered into the FAN program where erroneous transactions are written to an exception file, and each changed master record is formatted and written to a file for printing. These files are then read into the FEEDER program, an on-line program for transmitting information back to the originating district office. The new master file is also entered into the FORMAT program, where management information reports are produced for the district offices.

As we said earlier, auditing around this system would require reconciling input transactions to output reports. A parallel test deck would require not only a special processing cycle but also program modifications to the on-line EDIT and FEEDER programs, since a different form of data input and output would have to be used for test data. Furthermore, neither of these approaches would test the system's performance unless additional steps were taken to trace specific live transactions through the entire system. If an integrated test facility were used to test this system, audit records would be stored on all files and reflected in each of the district offices' management reports. As discussed, each of these approaches has its drawbacks.

Description of the Simultaneous-Parallel Approach

With the simultaneous-parallel approach, two new programs are needed—one to split test transactions from live transactions at the beginning of the system, and one to merge them back with live transactions at the end of the system. These should be very simple programs which look for a certain combination of data fields, selected by the auditor, which identify transactions as test cases. Figure 2 shows where the SPLIT and MERGE programs would be inserted into our management information system.

Once test transactions are split, they need to be put somewhere! We recommend that they be put on a direct-access device so that they will become transparent to ADP operations personnel. In other words, ADP operations personnel will not be required to mount and dismount additional files containing only test records and thereby distort the system's performance. Since the volume of the test data is normally less than actual live traffic, the space required on the direct-access device should be minimal. Of course, if the required direct-access devices are unavailable, tapes will have to suffice.

Now that test transactions are stored on the direct-access device, there has to be a means for getting them through the system. This is done by the operating system's job control language (JCL). The JCL is the machine instructions used to define input and output files, the program to be executed, and the format of listings or other outputs which should be written. With the simultaneous-parallel approach, a 3-step method of JCL is used. The first step of the JCL is the same as that used in normal production, calling the tape files for the particular program being executed. Step 2 is simply a check program to see if the test portion, step 3, should be run.

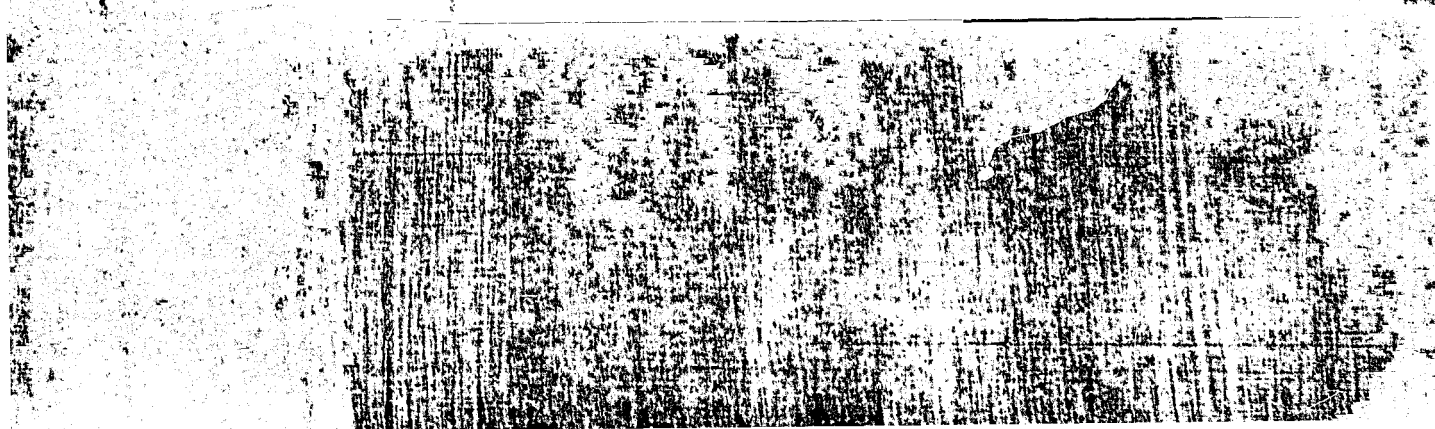
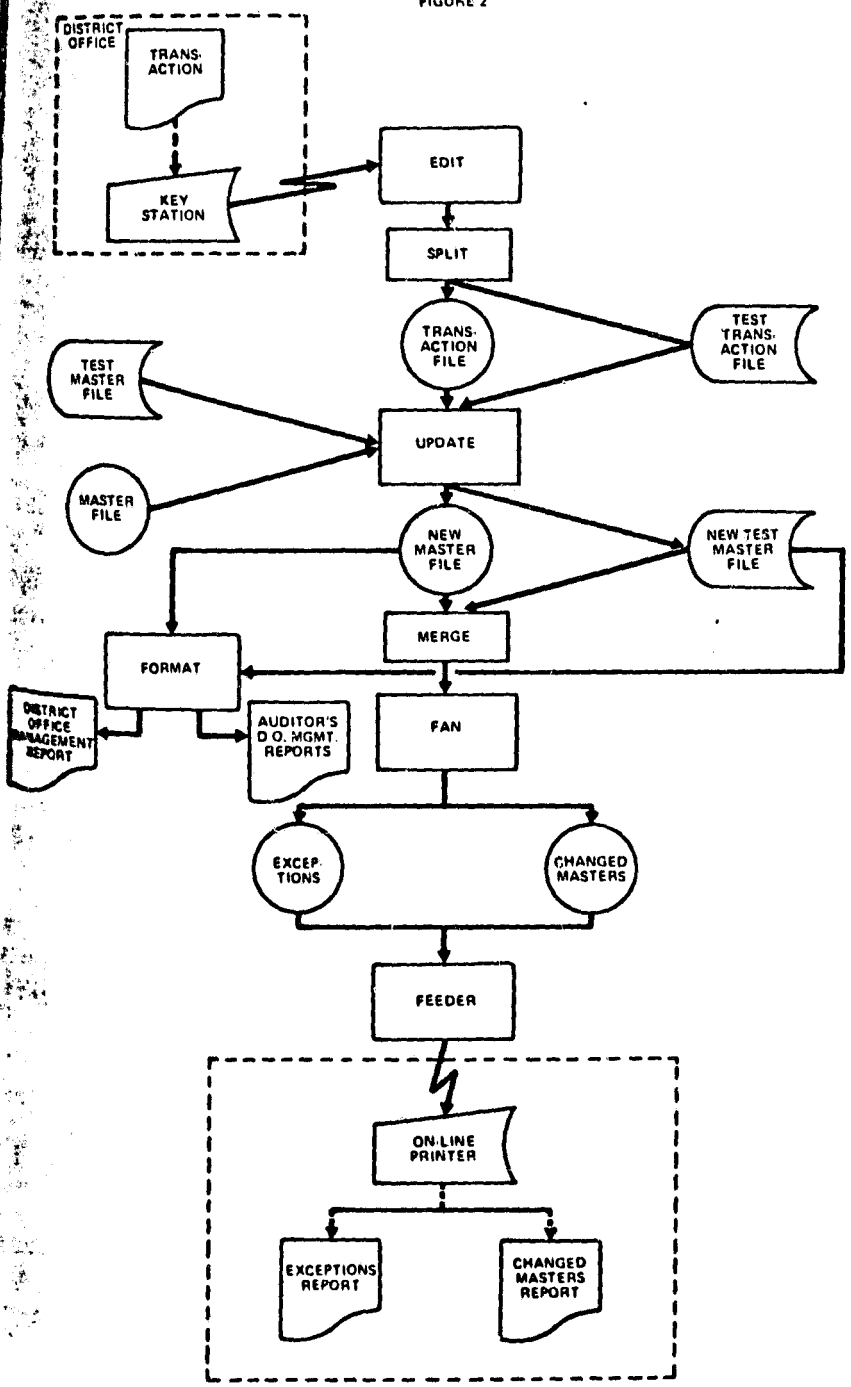


FIGURE 2



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The JCL for step 3 is identical to that used in step 1, except that the test facility's direct-access device is substituted to define it as input and output, rather than tape files.

As our management information system operates, live and test transactions will be entered simultaneously, through the on-line system, and separated onto the live and test data bases by the SPLIT program. The first JCL step is then used to process the live transactions through the UPDATE program as usual. Before the new master can go into the FAN program, the second step of the JCL will check to see if test data should be run, and, if it should, the third step of the JCL will call for the test data to be processed through the same program as the live production. Once both new masters have been created, they will both be called by the MERGE program, which will put them together for the FAN operation. Live and test transactions will thus be stored together on the exceptions file and on the changed masters file for simultaneous transmission through the on-line system.

The FORMAT program creates important management reports for the various district offices. These reports obviously should not include test transactions; therefore, we use the same 3-step JCL method to produce separate reports for the district offices and the auditor.

One additional requirement for the auditor using this approach is that he will have to make sure that test data is not treated differently from live data. Also, program modifications will have to be controlled to make sure that changes are not made which would affect only test data. An automated documentation package can be used to fulfill this requirement, identifying and tracing lines of program code which affect critical items of test data.

Advantages of the Simultaneous-Parallel Approach

The basic advantage is that auditors can simulate the entire workings of the system without affecting critical outputs or system operations. Specifically:

- Test records are on a separate data base and thus cannot affect live production.
- Test records are on a separate data base and can be effectively controlled by the auditor.
- Auditors can evaluate system performance since live and test inputs and outputs are merged together and processed at essentially the same time.
- Auditors have assurance that test transactions are subjected to the same program as live production by verifying the JCL (step 3 to step 1).
- Step 2 of the JCL allows the test facility to be turned off when not in use.
- Step 2 of the JCL allows the test facility to be turned off if problems arise which would prevent critical processing.
- A mini-version of the entire system is available for validation of new programs or program changes without running the entire live system.
- A permanent test facility remains for testing at a future date.
- The test facility requires a minimal amount of new programing (SPLIT and MERGE programs) and can be added easily to an existing system.
- Recommendations for improve-

ments to internal controls and performance can be made at the program level, showing exact lines of the program code that need to be modified.

For these reasons, we believe that this approach benefits not only the auditor's evaluation of the computerized system but also the system analyst and programer when changes are needed.

Disadvantages of the Simultaneous-Parallel Approach

Outside of the programing effort of the SPLIT and MERGE programs and the 3-step JCL, the only major drawback of this approach is the allocation of the direct-access device(s) for storing test records. It may not always be feasible to acquire these devices, and if the system being tested is small and not time dependent, test records can be allocated to magnetic tapes. The investment in direct-access devices must be weighed against the additional burden this approach would have on actual processing operations.

Conclusions

In summary, we believe that the simultaneous-parallel approach for testing computer systems is a valuable new tool for evaluating both internal controls and system performance. It is pertinent today, and even more so in the future: with the increased use of on-line and real-time systems this approach will permit the auditor to continuously monitor the system's internal controls and performance.

GAO and ADP

In the 11 years since enactment of the Brooks Act GAO has issued a staggering 175 reports dealing with the ADP problems. This averages about one every three weeks.

GAO's theme throughout all of this has been greater Government-wide coordination and centralization.

"The Federal ADP Procurement Maze"
Government Executive
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