USE OF AUTOMATIC DATA PROCESSING EQUIPMENT AS A TOOL FOR MORE
EFFECTIVE PRE-AUDITING OF SOURCE DOCUMENT INFORMATION

John H. Smith, Ohio Department of Highways

This paper describes the methods in which management
reports have been made more reliable, useful and
timely through more effective use of the computer
and input devices as an accounting tool. Reports in
terms of dollar relationships have been complemented
in terms that management can more easily relate to.
The conversion of source document information via
card punching or key taping has been eliminated for
all labor and equipment usage documents by use of
optical scanning equipment. The optical scanner
reads handwritten numbers and letters and transfers
this information to an on-line computer and is auto-
matically placed on tape ready for computer pro-
cessing. This data entry method is extremely
accurate and fast. A comprehensive computer edit
program is used to check the presence of required
data, validity, compatibility, and arithmetic
accuracy. Time and cost savings together with
information that can be related to has provided
support and participation by management.

The need for art in the recording, classifying, summa-
rizing, and interpreting of transactions of a financial
character has never been so much in evidence as that required
by today's accounting systems to meet management's needs. In
addition to our responsibilities of maintaining adequate
budgetary and appropriation accounting systems, cost accounting
and other management information systems also rely on the re-
cording, processing, and furnishing of accurate data via timely
reports.

Management's evaluation of reports should act as an action
stimulant. Criticisms include too voluminous to interpret and
too late to be of value, as the chief complaints. Delays in
management decisions are blamed on inadequate and/or erroneous
information. Another complaint is that action is too frequently
expected from conclusions gained from presentations containing
only dollars as the criterion of measurement. Other important
quantitative indicators of effort and conditions are overlooked.

Responsibility to improve the above rests with both
management and operating personnel. And while management hasn't

been overly eager in suggesting complementary criteria to
supplement dollars with which engineering efforts and results
can be judged, information systems can and must be improved
if we are to perform the functions of accounting effectively.

We do not have to look too far for the major causes of the
problem. Causes are numerous and obvious. Most of us are
generally hard-pressed getting documents from the field, per-
forming time-consuming pre-audits prior to payment, processing
the data for computer entry, and correcting and balancing
tabulations prior to report generation. The adage, "To err is
human", lack of communication, misinterpretations, and pressure
in meeting deadlines all contribute to the problem.

The number and varied types of transactions and individual
coding requirements, practically dictated that automatic data
processing equipment be used for accumulating and summarizing
of data and the printing of reports. However, the manual
methods most generally used in converting data to computer
language are very time-consuming, expensive, and error-prone.
Data preparation via key punch cards or key tape requires
hundreds of man-hours and in the interest of gaining turn-around
time, often results in too little time available for utilizing
the edit capabilities of the computer. Usually the editing
techniques provide only or little more than an arithmetic check
on the accuracy of data processed. Validity and compatibility
checks are usually left to visual means, post auditing
techniques, etc.

In Ohio we feel that we have made great strides in speeding
up the process from source document preparation to report
generation. Under our former system it seemed that accuracy
and timeliness were not compatible objectives. The more we
added to our machine edits, the more cumbersome the correction
process became with resulting delays in producing and furnishing
reports. We were confronted with the alternatives of stressing
timeliness and sacrificing accuracy, or stressing accuracy and
delaying reports. Under our present system both accuracy and
timeliness have been significantly improved.

Improvements were effected through a combination of the
following:

1. Installation of Optical Reading Equipment as a computer
   input device for all labor and equipment documents.
   This eliminated the manual keytaping of over one million
   five hundred thousand characters each bi-weekly period.

Data preparation in terms of days has now been reduced to hours.

The Optical Reader used by the Ohio Department of Highways is an IBM 1288. The 1288 is an optical recognition device that reads hand and machine-printed numbers and a selected group of alphabetical letters, and transfers this data to the computer system for processing.

For example, the actual time and equipment usage documents as produced in the field and central office units are stacked and fed into the reader much the same as punch cards are stacked and fed into a card sorter. Each document is transported into a light tight chamber where a flying beam of light scans the document. Whenever a dark image appears representing a number or letter, it traces around the image, compares it for recognition, and if recognized, causes it to be accepted and recorded on tape. A complete document is read in about one-half a second.

As an example of why we feel that great strides have been made in getting data into the computer in an accurate manner, a pilot test revealed that the optical reader received 806 time sheets, read 804, and rejected 2. The 802 read contained 61,124 hand-lettered characters. This data was read, transferred to the computer and placed on tape in 7 minutes. There were 166 characters not read and 3 character substitutions. The percentage of hand-lettered characters free of error was 99.70. In over two years of using the optical reader our normal rate of error is about .007 percent. This higher rate is probably due to the exercising of more care in the pilot test than is accomplished during normal use.

Upon conclusion of the pilot test we had proven to our satisfaction that optical reading devices could greatly speed up the introduction of data into the computer, and in an extremely accurate manner. It read and caused to be recorded almost exactly what was recorded on the source documents, but ... how accurate was the source document information? How accurate were the county timekeepers, project clerks, and others in recording the data? Was the data

supplied valid and compatible within a line item?

2. We designed and installed a comprehensive pre-audit program for application by the computer.

Our post-audit reviews under the former system determined that a considerable number of transactions contained one or more errors in a line item which weren't compatible with other information furnished. Supporting data in a field such as a bridge number might not be present, yet the activity code indicated that work involving a bridge was performed. Routes that do not exist, job numbers that haven't been issued, errors in using standard county abbreviations, and other similar type conditions were causing erroneous data to be processed and unless caught prior to the release of reports, naturally cast doubt in the mind of the user as to accuracy and reliability of the information.

The comprehensive pre-audit by the computer has practically eliminated these types of errors in our reports.

Part of the cause contributing to the overall problem was eliminated when we decided to have the computer pre-print the time sheets to be used during each succeeding pay period. The employee's name and title are pre-printed along with his hourly rate, Social Security number, period ending date, and work unit. The pre-printing of this data is accomplished through a master personnel control file stored in the computer and practically guarantees accuracy since the optical reader can easily read the pre-printed data. Pre-printing of repetitive data not only saves the time of the individual in not having to record this data but saves countless hours in overcoming the errors and problems caused by an individual inadvertently entering an incorrect hourly rate and/or erroneous Social Security number. Pre-printing also enables the individual to concentrate on the various work coding requirements that answer the questions of "Where, What, Which, How," etc. The answers to "Who" and "When" are automatic.

While personnel in the computer and accounting section were engaged in the process of writing programs

and re-designing source documents to effect the change
from the entering of data via key tape to use of
optical reading equipment, accounting personnel were
busy setting forth all the known "ground rules" for a
comprehensive computer editing program. The Legis-
lative Appropriations formed the foundation for the
edit system.

In Ohio, the amount appropriated to the Depart-
ment is sub-divided into Appropriation Items, such
as Personal Service, Maintenance, Equipment, Special
Purposes, Contracts, Right-of-Way Acquisition, Right-
of-Way Fees, Consultant Engineering, Lands and Buildings,
etc. Budgetary allocations of the appropriation items
are made to the various programs comprising the major
departmental functions; i.e., Executive, Administrative,
Planning and Programming, Right-of-Way, Design and
Construction, and Operations. Each program consists
of as many activities as necessary to adequately
describe the specific type of work performed. Legis-
lative control is exercised only upon the Appropriation
Item. The Department makes and controls budgetary
allotments to programs, and while work is reported by
activity, allotments are not made at that level.

Our edit program is based on the above and
performs the following in addition to the built-in
checks and internal controls of the computer:

(1) Arithmetic: i.e. add, subtract, multiply, divide,
     balancing detail to control totals.

(2) Verify presence or absence of data in certain
     fields and if present, its validity.

(3) Data compatibility check - Data in certain fields
     requires compatible data in other fields.

(4) Alphabetical validity.

Personnel in the Accounting Department prepared
charts listing each valid appropriation item, program,
and activity. Each program relates to a specific
function, and activities are common only to a specific
program, except indirect activities such as vacation,
sick leave, holiday and similar type indirect charges.
Certain activities within the functions of planning,

research, preliminary engineering and design, right-of-way, and construction require use of direct job numbers, while other activities of an indirect nature require use of an indirect job number. The chart listed all these relationships.

Job numbers are authorized by engineering phases, i.e. preliminary engineering, right-of-way, and con-struction. Thus a list of active jobs was prepared and identified as to the phase(s) that a valid charge could be made. This list is kept current; i.e. updated for each new phase authorized, and deleted when a phase has been completed.

A typical data edit of an engineering time or equipment sheet might look like the following from an accounting point of view:

(1) If hours are shown on Line A, Column 3, take rate shown in Column 19 and multiply and record.

(2) Verify presence and validity of Division Number shown in Column 4.

   (a) If missing or invalid, reject and note.

(3) Verify presence and validity of program number shown in Column 5.

   (a) If missing or invalid, reject and note.

(4) Verify presence and validity of activity number in Column 6.

   (a) Is it compatible with the program? If no, reject and note.

   (b) Is it a direct activity?

(5) Verify presence and validity of job number in Column 7.

(6) If present and valid, is it a direct job number?

(7) Etc.

The editing of the programs comprising the Operations function; i.e. Maintenance, Traffic, Garage, Lands and Buildings, etc. is similar to that of Engineering. Charts were prepared showing the various programs and the activities applicable to each. In addition to the program-activity type edits explained above, certain activities require use of a county, route, route type, and control section, while other activities may require only a county and route designation. Certain activities require use of a specific park, building, or bridge number. Unless all necessary information is present, valid, and compatible, the entry is rejected.

We also maintain special test sections throughout the State where particular attention is given to more specific information so that such things as route type, surface type, multiple lanes, traffic counts, etc. can be analyzed and evaluated. A master file of test sections is stored in the computer and is the key to reject any line item which is not complete.

The use of automatic data processing equipment as a tool for more effective pre-auditing has proven to be a major asset in aiding the solution of the problems mentioned previously; however, its potential and advantages are far greater than can be considered in this writing. One further example, however, is worthy of your attention and consideration.

We are presently installing terminals to allow information necessary for the vouchering of payment documents to be entered into the computer, edited, and the vouchers printed by the computer. This will eliminate the submission of documents to and from the computer section and also eliminates the duplication of work effort by accounting and data processing personnel. The printer is located in the accounting section with accounting personnel having full control over the entire process. The tape that is used to create the voucher output will be submitted with the vouchers to the Department of Finance and the State Auditor's Office and will eliminate the need of those offices to prepare the data for computer entry and will greatly facilitate the accomplishing of their appropriation and auditing responsibilities. Our systems will be compatible permitting the exchange of tapes.

3. Installed "On-Line" Terminals in the Accounting Department. The third area of major improvement was the installation of IBM 2260 Display Stations which are used to enter corrections directly into the computer. The terminals minimize the passing of source documents and error listings between the Data Processing and Accounting Department and the lost time in transit, logging, etc. and in addition, provides a better method of entering corrections and verifications.

Data that is rejected consists of two reports. The first report identifies the document and line item containing a character(s) that could not be read by the Optical Reader. Each document is numbered in the reading process and an asterisk is caused to be inserted on the error listing above the character field identifying the reject. An operator at an IBM 2260 Display Station with the reject report and matching source documents merely types the correct character using the 2260 keyboard and automatically updates the data stored by the computer. The reject report is submitted to the unit responsible for the errors and is an effective bi-weekly communication of their efficiency or inefficiency, depending on the number of errors.

The second report relates to items rejected by the computer because of erroneous or missing coding. This normally requires communication with the originating unit in order to obtain the necessary information to correct the errors. Once this data is available, the information is corrected in the same manner as the previous reject report.

The improved accuracy of our reports has increased management's confidence in and use of reports. One prime example is our road equipment reporting. Current reports are provided shortly after the end of a fiscal period that are accurate in the identity of each piece of equipment in our 16,000-item inventory. Various reports are provided covering cost, usage, rental rates, depreciation, etc. This is giving us the opportunity to develop new management procedures for better control of our equipment - impossible before due to the time lag for processing source documents manually that contained numerous errors in equipment identity.

The improvements previously related have enabled us to work on other desired objectives. One of our major goals has been to furnish management with reports that they can relate to. Reports which use other quantitative indicators besides dollars as measurement criteria.

With management's assistance we have recently designed and furnished two reports which have generated a great deal of management enthusiasm. Without the benefits derived from the improvements in our system it is doubtful that management involvement could have been obtained and their interest retained.

The first of these reports is what we refer to as the man-days report. After all raw data has been read by the Optical Reader and placed on tape, a man-days report is printed by program and activity within each of the organization units comprising the Division of Operations. Eight hours represents a man-day. Each level of management can see at a glance where the work effort has been directed in each of the 88 counties during the preceding pay period, measured in man-days or men. This report is available within five days after the close of the payroll period and is a useful tool to exercise administrative control over the Division of Operations' work plan, a plan prepared monthly by counties showing priority, location, work item and estimated man-days necessary to complete the work plan. We are presently programming similar reports for use by engineering functions.

The second report is a series of bar chart presentations drawn by a plotter on-line to the computer. The graphs show by separate scale the cost of maintaining the highway and related facilities in terms of the average cost per lane mile and the existing condition of the highway and related facilities in terms of the number of deficiencies per center-line mile. A separate chart is drawn for each major work program; i.e. pavement, pavement roughness, guard rail, berms, drainage system, structures, litter, traffic signing and striping, weed control, etc. and portrays a county-by-county comparison within a field division. The five types of systems, i.e. Interstate, Major Thoroughfare Divided, Major Thoroughfare Other, Auxiliary, and Local highways making up the total State Highway System are shown separately.

These presentations are furnished quarterly and by plotting and dating each quarter, the change that has taken place since the last report can be easily observed. Cost information comes from the data stored in the computer from the bi-weekly

summaries. Lane miles for each system within each county is also stored in the computer.

The number of deficiencies per centerline mile is an actual count and/or measurement made quarterly by Central Office employees using random sampling techniques covering a number of two-mile sections within each of the five systems of highways.

Factors significantly effecting maintenance costs have been identified by means of multiple regression models. This will provide a good basis for plotting the estimated cost for each major work program, giving us an effective budgeting tool for allocating resources needed to protect the highway invest-ment. Many other benefits may be derived from these reports but the preceding should be sufficient to stimulate your interest.

In the foregoing pages we have related the benefits and advantages derived from a combination of three major changes in our system. We have had over two years' experience in using the Optical Reader and are in the process of converting other documents to its use. The overall cost of providing data conversion by this means has been most favorable although exact cost comparisons of the former and present system is difficult due to additional reports, comprehensive edits, etc.

The present monthly cost is about $4,700.00. This includes cost of the forms, pre-printing, optical reading, calculation of gross pay and cost accounting distributions and balancing, equipment usage calculation and distribution, editing and error correction. Personnel attrition in two years directly attributable to key taping of time and equipment documents presently saves $9,025.00 monthly. One important factor relating to cost reduction is that we share the cost of the Optical Reader with several State agencies who utilize it.

The use of Optical Reading Equipment is applicable to a wide range of source documents. Documents up to 8½ x 14 inches can be processed; however, re-design is necessary. Improvement in form design and easier use were also side benefits derived. Cost of supplies is similar.

Since the majority of us have become careless in writing numbers and letters, re-learning standard grade school teaching is necessary although the Optical Reader has a fairly wide acceptance range.

The Optical Reader can be used for processing 100 percent of the forms converted to its use - none have to be key punched or key taped.

In summary, we feel that our systems have been vastly improved through the combination of the Optical Reader, use of the computer as a pre-audit tool, and on-line corrective devices. This is enabling us to accomplish the accounting functions more efficiently and effectively. Perhaps even more important is that we are making progress toward solving the usual complaints of decision-making management - that reports contain erroneous data, are too voluminous to interpret, and are too late to be of value.