both sides of the equations (1), (2) and (3) the following set of algorithms can be obtained

$$u_{ij} = a_{ij} - \sum_{k=1}^{i-1} u_{ik}u_{kj} \qquad i \leqslant j$$

$$u_{ij} = \frac{a_{ij} - \sum_{1}^{j-1} u_{ik}u_{kj}}{u_{jj}} \qquad i > j$$

where u_{ik} are the elements of the composite matrix LU

$$w_{ij} = -u_{ij} - \sum_{k=j+1}^{i-1} u_{ik}w_{kj} \qquad i > j$$

$$w_{ij} = \frac{1}{u_{ij}} \qquad i = j$$

$$w_{ij} = -\frac{\sum_{k=1}^{j-1} u_{ik}w_{kj}}{u_{jj}} \qquad i < j.$$

Finally

$$b_{ij} = \sum_{k=i}^{n} w_{ik}w_{kj} \qquad i > j$$

$$b_{ij} = w_{ij} + \sum_{k=j+1}^{n} w_{ik}w_{kj} \qquad i \leqslant j.$$

In the case of a symmetric matrix, the matrix can be stored as an upper triangular, and the above algorithms modified by introducing the relationship

$$a_{ji} = a_{ij}.$$

Book Review

An Audit Approach to Computers, by A. Pinkney, 1966; 159 pages. (London: *Institute of Chartered Accountants*, 20s.)

The book has been published by the Trustees of the *General Educational Trust of the Institute of Chartered Accountants in England and Wales* at the suggestion of the Council of the Institute. The views expressed are stated to be the author's own and not necessarily those of the Trustees or of the Council, but coupled with the fact that this is the first book published in the United Kingdom on the subject will undoubtedly tend to make Mr Pinkney's book at least the unofficial standard text book on auditing computers for some time to come.

Does it deserve a place in the accountant's bookcase? The answer is probably both yes and no, the latter in the sense that any accountant with "computer clients" will find the book more used as a constant companion than one lying on a shelf waiting for the pages to be turned if occasion demands. The book is written primarily for the external auditor but internal auditors, management and anyone concerned with establishing and reviewing systems of internal control will find a wealth of information and interest, including even a review of the elements of a computer system.

The first chapter deals with general audit considerations and covers the audit approaches, audit trails, internal control and the co-ordination of audit and management requirements. Then follow three chapters on controls, the first two dealing with those related to the manner in which the work of the data processing department should be organized, and thirdly those required by reason of the way in which the applications are planned to be processed in order to achieve reliable output records. Among the many aspects covered are:

Systems description documentation described in simple detail with references to program security, authorization, testing and amendments.

The division of responsibility on which the system of internal control is based is given considerable attention with particular reference to computer operators and control section—two very important features from the audit point of view.

The manner in which files containing the processed data of the business may be safeguarded: procedural controls are considered under the main headings of input, processing (including typical program checks), master file and output, with several easily understandable examples.

At the end of each of these chapters are a number of paragraphs on audit considerations which are in the nature of a "re-cap" of the previous subject matter regrouped from the audit viewpoint. A number of questions which are posed for the auditor to ask when faced with the problem of EDP audits will no doubt be most useful although it is felt that the author's views on the answers (as appropriate) could also have been most valuable, or at least the questions could have been referenced to the relative paragraph in the text. Brief references made to the dangers inherent in weak control serve to remind that even with EDP the body of fraud can still exist.

With all the results of the auditor's review of systems and controls in front of him there still remains the problem of evaluation of the complexity of the results and to this end Mr Pinkney has proposed the use of a control sheet (with example) as an aid to assimilating the information. He also suggests that it will normally be helpful for the auditor to prepare a special questionnaire or check list to cover each of the control aspects that have been featured in the book. It seems a pity that Mr Pinkney did not go so far as to provide one for his readers which would have been readily accepted as the standard work. Or perhaps it is at this stage that the reader, having been so well provided, is tending to expect everything to be "served up" for him.

The next two chapters deal with purely audit functions. The first describes, primarily, audit tests in relation to a computer application but sounding the warning that regard must also be paid to the controls which operate outside the data processing department. The second considers special audit techniques including the use of test packs and special computer programs. Mr Pinkney takes the view that conventional audit techniques will normally be applied wherever the system of processing allows this, but where the efficiency of the audit can be increased or the cost thereof reduced by the use of special techniques these should be considered. He recommends that the auditor's tests should be directed towards seeing that the internal controls, both procedural

(*Continued on p. 149*)

```
array y,f,a,e,pred,pe; integer array n;
integer m,N,P1,P2; real w;

begin integer i,j,k; real F,YF,p,q;
      array T,Y[1 : m];
      k:=0; YF:=F:=p:=q:=0;
      for i:=1 step 1 until m do
      begin
            T[i]:=Y[i]:=0;
            for j:= 1 step 1 until n[i] do
            begin
                  k:=k+1; F:=F+f[k] ↑ 2;
                  T[i]:=T[i]+f[k];
                  Y[i]:=Y[i]+y[k];
                  YF:=YF+y[k]×f[k]
            end;

            p:=p−T[i] ↑ 2/n[i];
            q:=q−T[i]× Y[i]/n[i];
            e[i]:=(1+T[i] ↑ 2/n[i])/n[i]
      end;

estimates:    a[0]:=q/p;
              for i:=1 step 1 until m do
                a[i]:=(Y[i]−a[0]×T[i])/n[i];

sumsquares:   k:=0;
              for i:=1 step 1 until m do
              for j:= 1 step 1 until n[i] do
              begin k:=k+1;
                    w:=w+(y[k]−a[i]−a[0]×f[k]) ↑ 2
              end;
              w:=w/(N−m−1);
              e[0]:=sqrt(w/p);
              for i:=1 step 1 until m do
                          e[i]:=sqrt(e[i]×w);
predictions:  for k:= P1 step 1 until P2 do
              begin i:=k−m×(k−1)÷m;
                    pred[k]:=a[i]+a[0]×f[k];
                    pe[k]:=w×(1/n[i]+(T[i]/n[i]
                      −f[i]) ↑ 2/p);
                    pe[k]:=sqrt(pe[k])
              end

      end of season;
```

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Book Review (*Continued from p. 134*)

and organizational, are functioning properly, and this chapter provides even newcomers to EDP with sufficient information to carry out a detailed audit.

Reference is made to the verification of balance sheet and profit and loss account items, and the suggestion is made that here may be a field for the auditor to use special computer programs, e.g. random sampling instead of a complete print-out of a file: print-out reports of items which fail to meet specified criteria. There are also two examples in some detail of the use of special computer programs, one on a large payroll application and the other in connection with the verification of the valuation of a company's hire purchase debtors. On the question as to whether an auditor has a responsibility to examine computer programs it is clear that the author has made up his mind that such a task is neither a practical nor desirable approach, and he suggests the use of test packs as a more practical method for an auditor to satisfy himself about the validity and reliability of a client's computer programs.

The preparation, use, and limitation of test packs are referred to in some detail, followed by an example of their use in relation to a sales system. Only valid data is used and the processing is carried out by a duplicate copy of the client's program. There is, however, no advice as to how to check that the duplicate used is a true copy. The "pros" and "cons" of these techniques are carefully weighed and the reader is not discouraged from seeking further development. Mr Pinkney concludes with these words, "The auditing of computer applications is still at a comparatively early stage and it has become clear, in the course of preparing this book, that a great deal of further work remains to be done. It is hoped that the suggestions contained in the preceding pages will assist these further developments."

It is thought that this book will currently be of great assistance both as a reference and a guide and will stimulate future thought and work.

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