the calculating time was reduced to 6 minutes. The 7090 has now given way to the 7030 ("Stretch"), but our payroll preparation is now carried out on an I.B.M. 1401.

The use of the 7090 as a standby for a 604 system may appear at first sight to be ridiculous, but from it we learned the hard way some of the problems of magnetic-tape systems, and at the same time had an effective emergency standby for our payroll responsibilities.

We have also used the 7090 for a stock-control application, and in connection with actuarial valuations of our Superannuation funds.

None of these jobs were particularly outstanding in themselves, but by the time our I.B.M. 1401 arrived in September 1961, we had become accustomed to dealing with computers. We are now physically integrated with our scientific colleagues. Two compatible and fully interchangeable I.B.M. 1401 Tape Systems stand side by side serving either the Stretch as off-line equipment, or the ever-growing needs of the administration. This arrangement has obvious advantages, and we feel rather proud that we have progressed from punched cards to the joint use of computers in less than five years.

The integrated accounting system

It would take much longer than this paper allows to describe in any great detail the integrated A.D.P. accounting system, but from the following prime documents:

(1) Stores transaction vouchers.
(2) Suppliers invoices.
(3) Journal and cash book vouchers.
(4) Orders placed.
(5) Clock cards (punched cards) and attendance records.
(6) Personnel records.
(7) Pay records.

The following end products are achieved:

(1) Costs statements.
(2) Budgetary control statements.
(3) Payrolls and associated information.
(4) Superannuation records.
(5) Traders credits, cheques and remittance advices.
(6) Stores ledgers.
(7) Personnel statistics.
(8) Rent and hostel ledgers.
(9) Various day books.
(10) Creditors accounts.
(11) Vote accounts (system of accounting peculiar to Government Departments).
(12) Miscellaneous management statistics.

There are two further applications which are in the process of development:

(1) Stock control—using Keyboard/Punched-card links.
(2) Inventories of assets and equipment.

The 4K store of our present 1401 Tape System will be increased to 8K next year, and by this time we plan to make a critical examination of our whole accounting system. This we feel we are in a better position to do than previously, for we are now confident that we can at least handle the hardware.

Conclusion

Our approach to the whole problem has been based on the logic, rightly or wrongly, that there is no substitute for practical experience. We have never aimed for, or claimed sophistication, but rather have concentrated on learning a new trade. Sophistication can come later.

(*For discussion at Cardiff see p. 11*)

LEAPS—the first three years

By W. S. Ryan

This paper describes some of the problems of applying computers to time-critical work.

1. Introduction

The initials LEAPS stand for London Electronic Agency for Pay and Statistics, a Post Office computer installation situated in Armour House near St. Paul's Cathedral. The first objective of the computer project, on which work commenced in 1956, was to compute salaries and wages for the 112,000 Post Office staff employed within the London Postal Area.

LEAPS equipment consists of:

2 National-Elliot 405 computers, each with 5 magnetic-film mechanisms split between 2 film units, and appropriate peripheral equipment for punched paper tape and card input and tape output.

2 off-line Samastronic printers, each with a spare switchable printhead.

Operational work began in April 1959, and since then the load has been progressively built up. At present the payroll load is 48,000 weekly and 7,500 monthly payees, all employed in the London area.

In addition LEAPS processes pensions for 52,000 ex-Post Office employees (12,000 weekly and 40,000 monthly), prepares Overseas Telegraph Accounts, telephone exchange line costings, and telephone service statistics. Paper tape is the input medium used for all payroll and pensions work; punched cards are only used in one or two of the smaller applications.

Weekly payroll work cannot commence in LEAPS until about noon on Monday because of the short lying-time conditions obtaining in the Post Office, whereby most weekly-paid staff receive payment on a Friday for overtime performed up to and including the previous Sunday. Monday morning is therefore required in the local units for compiling the input. To allow time for preparations for payment at local units, starting with Night Staff on Thursday night, LEAPS has to complete its weekly payroll processing by early afternoon on Wednesday. Only in exceptional circumstances can these outer time limits be exceeded, and then only at the expense of considerable extra work in local offices. Processing for Post Office pensions and monthly salaries follows directly on completion of the wages payrolls. The salaries processing is almost as time-critical as the wages work, and although there is a little more latitude with the pensions job, even this cannot be delayed by more than a few hours without unfortunate results. The remaining processes are rather more flexible.

2. Agency aspect

It is an important feature of LEAPS operations that the installation operates entirely on an Agency basis; thus for payroll it is responsible for the accurate processing, within the agreed time schedules, of data sent to it from 18 local offices, comprising 31 individual payrolls. The local units are responsible for sending correct input data at the appropriate time to enable the Agency to perform its functions and, in the event of any payee's conditions changing between despatch of input and pay day, for effecting the necessary changes to the week's pay. The arrangement fits in well with the organization of the Post Office, which consists of a large number of local units having a high degree of autonomy, especially in the pay field, but obviously calls for very close co-operation between LEAPS and the "customer" units. This co-operation is based on strict adherence, both by LEAPS and the local offices, to the weekly timetable, prescribing input and output times for each unit, and strict adherence by wages clerks in local units to their manual of instructions for the LEAPS pay system. Instruction manuals describe in precise detail the form in which all input is to be prepared and sent to LEAPS, the forms of output provided, and the payment procedures.

3. Conversion to computer system

(*a*) With one exception, at which keyboard accounting machines were in use, all the local units had previously produced their payrolls by a manual method, on the lines of the pegboard system, and this posed a large-scale problem of data conversion before payrolls could be converted to the computer system. Because the task was obviously too large for local wages staffs to handle unaided, and was to be repeated in a number of offices, it was decided to employ a specially trained implementation team (the Task Force) of about six to eight people, with its own supervisor, to undertake the work.

(*b*) The initial job for the Task Force at each office is to prepare a special "joiner" form for each payee, containing all the necessary standing information, name, pay number, rank, pay group and pay point numbers, standard pay, fixed allowances, current tax details, standard deductions from pay, etc., and to despatch them to LEAPS. Here the data are punched and verified on paper tape, which is processed to produce the LEAPS standing file on magnetic film—one block of 64 32-bit words per payee. This, in turn, is processed on a "no data" (i.e. no input) run, which has the effect of giving each payee his standard pay for the week, plus or minus appropriate additions and deductions, to provide individual pay records, proof sheets, and analyzed balance totals. The pay records and balance totals are compared in detail with the local (manual system) records, and any discrepancies are noted for corrective input action the following week. Since the bulk of this task has to be done for about 2,000 payees—the average size of a local unit—between Wednesday morning and the end of the week, the need for a special Task Force will be appreciated. A certain amount of advance preparation can be done, largely in parallel with the manual payroll, but up-to-date pay details including cumulative totals of assessable pay and tax paid as at the end of the week, are not available until the manual system pay calculations for the week are completed.

(*c*) Local wages staffs need to be thoroughly trained in the new system if it is to work smoothly with a reduced local wages force from the start—it being a principle of implementation of the LEAPS system that the staff is reduced to the new level, only about 40–50% of the previous number, immediately the new system is introduced at each office. Effective training is best provided by means of a full-time training course followed by desk training on live work—provided personnel can be freed from their normal tasks during the training period. Here again the services of the Task Force are invaluable, for having had a thorough grounding in the new system they are eminently fitted to fill the breach caused by absence of local staff. In each office they take over the wages posts whilst the required number of local wages clerks go to the training school for a LEAPS wages conversion course, and when the trainees return, the Task Force sit-in with them for a week's desk training—one Task Force member to one local staff member. Thereafter the Task Force is withdrawn from that office to commence the process again at the next, but with the understanding that the Task Force supervisor will answer inquiries by telephone and, if necessary, will send one or two members of the force back to a previous office to handle any special difficulties which might arise. Thus each local unit has, at the time of the changeover, been given the new system as a working concern, and with a ready means of obtaining advice and help during the initial settling down period. This procedure has proved entirely successful in practice and although, as one would expect, the performance of local staffs has varied—some have produced numerous inquiries and needed occasional help for the

first three or four weeks—none has failed to settle down, within a reasonable period, to a smooth and efficient performance.

(*d*) Before introduction, each main payroll program was thoroughly tested, initially on test data designed to simulate the widest possible variety of combinations of pay changes and personnel movements, and then on live work in parallel with the existing manual system. This parallel run of each payroll system was carried out in the first local unit to be converted, with the Task Force operating the LEAPS system, and lasted for eight weeks. This may seem to be a rather long period, but it was invaluable in clearing the last few bugs out of the program, remedying the inevitable systems snags, and in familiarizing the Task Force with their work. In introducing the new system at the next few offices the parallel run was progressively reduced to four weeks, then to two, and finally to one week for all the remaining offices. The parallel run of one week, even after the system and programs have been proved, serves an important purpose in that it demonstrates to each local management that the system will work effectively in *their* office—in fact the team supervisor presents the final balance from each system together with explanations of the differences, invites the local manager to examine them, and then to decide whether payment that week should be made from the LEAPS output. We have never had an unfavourable decision. Resolution of the differences is another purpose of the one week's parallel run. A great many differences arise under the LEAPS system because the computer calculates overtime to the nearest penny, whereas the Ready Reckoner tables used under the manual system give only an approximate answer. But all other differences arise from human error, either on the part of the LEAPS system (for example, errors in input) or the manual system (for example, errors in reading Overtime Ready Reckoners and Tax Tables). Experience over a wide range of local units has shown that on average only one error occurs in the computer system for every ten in the manual system. Furthermore, the system of balancing controls built into the LEAPS system ensures that almost all errors are immediately brought to notice, whereas a large number of manual payroll errors get by unnoticed.

(*e*) Mention has already been made of the fact that in each local unit wages staffs are reduced, by 50–60%, to the number required under the new system directly the system is introduced. To be able to do this successfully it is essential to know what staff is needed and to be able to convince local staff representatives that fair assessments have been made. The O & M team engaged on the project were, at a comparatively early stage, able to give a firm estimate of the new requirements, because they had thoroughly studied the manual system and had created the new computer system to replace it. Something more than this was needed, however, if justice was to be seen to be done, and we have found that the best method is to get local staffs to compile a detailed record for one week, of the time which they take to carry out the various manual-system operations. Preparation of this record is closely supervised and the results are analyzed under two headings to show the amount of work which ceases when the LEAPS system is introduced, and that which remains to be done in the local office. Additions to the latter are made for new operations in the LEAPS system, to give the total weekly time requirement under the new system, and hence the number of staff required.

(*f*) Staff relations throughout the introduction of the scheme have been good. There have been, and no doubt there will still be, some fierce arguments, but the important thing is that the machinery of consultation works well and reveals points of possible disagreement before they can cause trouble. The staff side of the Post Office Departmental Whitley Council was consulted in 1957, when we were in the very earliest planning stages, and the Council set up a joint sub-committee of official and staff-side members to deal with all aspects of the scheme at the Headquarter or central level. The joint committee meets regularly and clears the general principles for each system and its application, leaving the details to be hammered out in joint discussions in the local units affected.

4. Operations

(*a*) *Data Transmission.* The input data for the weekly and monthly payrolls consist broadly of any permanent and temporary changes affecting each payee in the current pay cycle, plus standing information for "joiner" payees. The data is sent to LEAPS by each local unit in the form of coded instructions on forms specially designed as punching documents. Because LEAPS caters for a variety of grades working under a wide range of conditions, the amount of input data varies greatly. At some local offices where the input load is light, unit documents are used; but at other offices with a heavy input load, multi-line documents are used, pre-printed in LEAPS with names and pay numbers in the order required for payroll. This latter system, of course, avoids the need to sort the input before processing, thereby saving valuable time in a peak-processing period, at the expense of an off-peak printing job. This is one example of how the LEAPS system has been shaped by the need to cut processing time to a minimum during the payroll peaks.

Various methods are employed for transmitting the documents to the Agency. Since most of the local units served by LEAPS are in the London area, and the Post Office has a large motor-transport fleet, most delivery of input and collection of completed payrolls is done by van. In some cases, normal postal services are used, and have proved entirely reliable; in the case of pensions, where the customer unit is situated in Yorkshire, special despatches on overnight mail trains are used. It may be wondered why the Post Office, with all its telecommunications know-how and resources, is not using line transmission. In fact, this possibility was looked into very carefully during the early planning stages, but because of the many local units served and the peaked nature of payroll work, the provision of data-conversion staff and

equipment on a decentralized basis would have been grossly uneconomic.

(*b*) *Work Scheduling*. In order to make the most efficient use possible of both staff and machines during the peak-processing period, the flow of work through the Agency has to be very carefully phased, and the arrival of input and despatch of completed payrolls made to fit in. Staffing in each local pay branch in its turn is geared to the input and output times allocated to that office, and it therefore becomes essential that, once laid down, these times should be adhered to. Generally speaking, LEAPS gives a 24-hour service, but since the Agency is not working shifts, these 24 hours are whittled down to about 10 working hours. Each payroll goes through six consecutive processes in its preparation:

(i) Clerical assembly of input for punching.
(ii) Data conversion—punching and verifying.
(iii) Computing—single run.
(iv) Off-line printing of payroll documents—two runs, the first for pay advices and proof sheets, the second for postal drafts for payees who cannot be paid in cash this week.
(v) Guillotining of pay advices and postal drafts.
(vi) Clerical scrutiny, assembly and despatch of output.

It is obvious that delay in any one of these processes must perforce be reflected through all the subsequent processes. Delays can arise from a whole variety of causes—late arrival of input, erroneous input, tape error, program error, faulty magnetic film, machine breakdown —and in work-scheduling for such a concentration of time-critical work it has been essential to take as realistic a view as possible by allowing a reasonable margin to meet these contingencies. In LEAPS we have allocated a target time to each machine run on computer or printer; at the outset, the target time may be a theoretical assessment of the minimum time the process can take, assuming no delays of any kind, but later it is based on a review of actual "good run" times achieved. To this is added a contingency percentage which reflects the average "excess over target" time. This percentage is obtained by analysis of the equipment logs, etc., and is kept under regular review as it is the most valuable yardstick of the efficiency with which the operational machine processes are being carried out. It is, of course, the constant aim of the Manager to bring this excess percentage down to a minimum, as it directly affects the work which can safely be loaded on to the machines. Statistics of this sort, to be of any use, must, of course, be reliable, and this in turn depends on the accurate recording of events *as they occur* by the operators in equipment logs, on fault dockets, and on progress sheets which accompany each payroll as it passes through the various processing phases. The importance of accurate recording to provide reliable management statistics cannot be overstressed, and efforts to achieve and maintain a high standard in LEAPS have been amply repaid.

With a work schedule in which each job has a contingency margin based on average performance, one is still not out of the wood. The trouble is that the time padding must perforce be spread evenly over the day, whereas delays are, generally speaking, compounded of a large number of very small delays and a few very lengthy ones. It is the incidence of those latter delays which determines whether or not LEAPS can shut down on time at the end of a day or not. Generally speaking, LEAPS must clear its scheduled work load day by day, in order to meet the payroll delivery times; it therefore follows that a lengthy delay of, say, two or three hours is far less troublesome if it occurs in the early part of the day than if it occurs, say, in mid-afternoon, because there is time to recover. The phased arrival of payroll input is another important factor. This is designed to provide a steady flow of work into the Agency, but it also means that normally there is not a large reservoir of payroll work waiting to be put on to the computers. Even if things go exceptionally well, therefore, it is not possible to get very far ahead of the work schedule, and it is sometimes necessary to push in other work to make use of the small pockets of time which then become available.

LEAPS has a process-control system, with a process controller in charge, whose job it is to ensure that the operational side of the Agency, and in particular the four main items of equipment, are at all times employed to the best advantage. He has a control clerk to help him and a display board on which are shown the scheduled jobs for the day and the progress so far made. He keeps a continuous check on the progress of work through the Agency, is notified of any significant delays occurring, and if necessary re-arranges the work programme so that as far as possible the correct priorities continue to be observed. When small pockets of time become available, he must see that they are used, either for small non-urgent production jobs or for program testing. When, because of delays, it is doubtful whether LEAPS can meet the scheduled output time for a particular payroll, the local unit has to be informed, so that they can re-arrange their staff attendances as necessary, and also re-time their collection service.

As already stated, the very nature of LEAPS' work imposes the need to clear the scheduled work load each day. This requirement brings with it the need for fairly flexible staffing arrangements, which can provide for late working at fairly short notice, since the need for such working arising from breakdown or operational delays of one kind or another cannot be foreseen. It is the process controller's job to keep a watch on the general progress position, to assess whether or not operations are going to run on beyond the scheduled finishing time for the day, and if so to make the necessary staffing arrangements.

(*c*) *Emergencies*. Because of the time-critical nature of payroll work, it was decided right from the initial planning stages of LEAPS that at no stage would the processing rely on a single machine. In particular, two medium-size computers were chosen in preference to a single larger machine; thus, if one half of the equipment suffers

a major breakdown, the other half can, by working 24 hours a day, carry the load. Such happenings, though rare, have occurred, so that in the event this policy has been justified. The LEAPS computers and printers have been so arranged as to form two virtually self-contained installations, each with its own power supply and ventilation machinery, thus minimizing the risk of complete loss of capacity due to fire or power failure. In the event of a failure in the public electricity supply, a mobile diesel generator could be used to keep a half of the LEAPS installation going. Obviously, the more time-critical the work, the more rapidly an emergency situation arises when breakdowns, etc., occur. We have considered it absolutely vital to specify quite clearly all the various types of emergency which could arise and the measures necessary to meet them. Having the welfare of its customers at heart, of course, the first aim in LEAPS is to safeguard the payroll delivery times, and late-night or through-night working is the first line of defence. We also have arrangements with other users of similar equipment (computers and printers) whereby we can make emergency use of their machines, although such use is generally only possible during the night hours. Another device we have up our sleeves, if because of printer breakdown the payrolls can be computed but not printed, is to use a bank of teleprinters to print an abbreviated payroll, but this requires a computer conversion run to punch out on paper tape the abbreviated payroll information extracted from the normal payroll print film. Fortunately, we have not yet had to resort to paying out from such a payroll, although we have had one or two very near calls. If, in spite of all these strings to the Agency's bow, it should become clear that the payrolls for the week cannot be prepared in time, then a "serious emergency" situation arises, and we have well-laid plans in such an event to make an approximate payment to each payee, and to clear up the over- or under-payments in a subsequent week. To organize these emergency payments and to effect the subsequent clearing-up operation would require a large manual effort, in the local offices, by a wages staff which has been depleted by more than half by the advent of the computer system; we certainly hope we shall never have to invoke this "last-ditch" arrangement.

5. Programming

(*a*) Because of the heavy payroll load the LEAPS Agency is planned to carry, and the pressure there will always be on the available processing time, it has been necessary from the outset to weigh up very carefully the relative merits of building into the main payroll program facilities which, prima facie, seem not only desirable but an obvious candidate for inclusion in a computer system. Such facilities as calculation of starting pay on promotion, and annual increments, are examples. All such "luxury" facilities were looked at first of all strictly on the basis of their economics. Just what extra savings, whether real or notional, would flow from providing such automatic facilities, and how much would it cost at the Agency? This cost, in terms of lengthened processing time, is compounded of:

(i) a more complex and therefore slower program;

(ii) extra data to be sorted in standing file, read into the computer, amended if necessary, and written on to the updated file for each weekly processing. This factor was emphasized in LEAPS, because the computers were designed to work on a fixed-length record, and it was absolutely essential to restrict each payee's record to one block of 64 words in order to keep the processing time within bounds.

Even if the provision of a facility could be justified on economic grounds, the overriding consideration that had to be met was whether the lengthened processing time was acceptable from the point of view of the operational timetable. Generally speaking, it is true to say that the LEAPS payroll system is a fairly spartan one. The lack of frills was to a large extent forced on us by the volume and time-critical nature of the work we had to do, but this may not have been a bad thing; it is only too easy to commit oneself in the early planning stages to fringe services largely of a prestige nature without weighing up the real costs.

(*b*) The speed of the main payroll program, as already made clear, is of vital importance in LEAPS. With 100,000 payees to process in certain weeks, every additional 1/10 sec in the cyclic speed of the program adds between three and four hours to the scheduled processing time.

Obviously, this aspect has received very close attention in our planning. At the outset, we greatly over-estimated the speed which our first payroll program would achieve. In fact it took four times as long as the initial estimates, which we had taken the precaution of doubling for planning purposes! We have improved on this performance very considerably since then. A rewrite of the original program in fact doubled its speed, which just brought it within the planned limits. More important, we do nowadays make rather better estimates of program speeds, but it is significant that, in spite of our experience, actual speeds of new programs still seem to turn out slower than the estimate.

(*c*) The slick, streamlined program, making as much use as practicable of the computer's time-sharing facilities and various other devices, is the obvious ideal, but it brings problems when it comes to program maintenance. "Sophisticated" programs are usually complex, and the smallest modification can necessitate quite a large-scale rewrite. Furthermore, unless the modifications are themselves optimized, almost all the benefits of the original optimization can soon be lost. Maintenance of payroll programs is bedevilled by two external factors—the frequency with which changes occur, and the speed with which such changes often have to be implemented. We find that, even after using a program operationally for two years, very few weeks go by without a modification of some sort. In order to meet the problem of program maintenance in LEAPS, it has been found essential to set

up, and maintain up to date, very comprehensive program records, consisting of system and program specifications, flow charts, fully-annotated program sheets, and sometimes a narrative description. Generally speaking, we have not gone in for fully-optimized programs, but have optimized only those parts of each program where the greatest contribution could be made to overall program speed. Also, in writing the original programs, we took the normal precautions to leave space for inserting additions or modifications. All these factors help the programmer in the job of program modification. There still remains, however, the problem of ensuring the accuracy of the modified program. With a large load of time-critical work, it has been found from bitter experience that the testing of even the most innocent-looking program amendment cannot be too thorough. In LEAPS, each main payroll program has its own dummy payroll which is used as a test-bed for program modifications. The wide variety of input data which can arise in payroll, either singly or in conjunction, makes 100% testing virtually impossible, and the test input used with the dummy payrolls is specially devised to test those patterns of input which most frequently arise.

6. Equipment maintenance

A lengthy breakdown during the weekly peak processing period in LEAPS can, as already described, cause chaos and, if prolonged, can result in expensive emergency measures having to be invoked. While it is not possible, for obvious reasons, to ensure that breakdowns do not occur during such crucial periods, measures can be taken to keep the loss of time down to a minimum. For example, it is essential that maintenance engineers are always immediately available over such periods. As soon as anything goes wrong which might be due to a machine failure, the LEAPS maintenance engineers are called in either to take over the machine or witness a re-run; if, on re-run, the failure recurs, then the engineers have a flying start on diagnosis. Another useful measure might be to step up the level of spares held on site. It is often the case that minor spares only are held at the installation, intermediate and major store items being supplied by the manufacturer on request in the event of failure. This applies particularly to electro-mechanical devices such as printers. It has been found a worth-while insurance in LEAPS to step up the margin of spares held in some categories, and to extend the range of stores held on site.

7. Conclusion

This paper has set out some of the many problems that have been met and resolved in developing the LEAPS project over its first three years. To those concerned in this development, these years have brought many periods of frustration but never a moment of boredom, plenty of excitement and mental stimulation, and that general feeling of satisfaction that comes with achievement. LEAPS is now paying its way, and with further applications being planned, an overall profit is assured.

I conclude with my very sincere thanks to my colleagues in my Branch and the Accountant General's Department who have done the hard work in preparing this paper.

Summary of Discussion at Cardiff Conference

Mr. B. A. Greenway (*Glamorgan County Council*): To go back to the remarks of the first speaker, up to now when we talk of integration I think we have all meant integration within the organization, but I think that future developments demand that we should have integration of a much wider nature, that we should have cross-acceptance of each other's output data. There are one or two heartening examples at the moment. At Munich I heard Mr. Dudley Hooper (*National Coal Board*) describe how their many transactions with British Railways, which used to mean a lot of paper work, have now been reduced to the processing of one set of information at the time that the coal is consigned on the railway, and all the accounting flows from that.

We have another example in the Ministry of National Insurance, who are preparing to be able to accept users' output cards, provided they are in a certain form, for the records of graduated pension contributions. I wonder how far we are away from the day when we shall all have banking accounts with the same bank and all the public utilities and some of the other people will merely send punched cards to the bank and our accounts will be adjusted automatically. How far we are away from the day when the Steel Company of Wales will accompany each of their consignments with a batch of cards from which, say, Pressed Steel will update all their stocks records? I think this is a development which must come. One of the things which stand in the way, of course, is mutual mistrust, and probably people like auditors; but I see that the Post Office have gone one step towards making this more feasible in that, with their system of subscriber trunk dialling, they have made it absolutely certain that you cannot check your account!

Mr. J. R. Hopkinson: There is very little I can add to that. As I mentioned, integration is a very big word and it calls for a lot of imagination. When you work it out in your own installation one does spend a great deal of time preparing pieces of paper to send to other people; cheques, traders' credits, invoices, etc.; but I think it will need a bit more than imagination, it needs standardization and get-together and, of course, as you have mentioned, mutual trust.

Mr. W. S. Ryan: I think perhaps the questioner might be interested to know that we have made a small step in this direction in the Post Office in LEAPS. Each LEAPS payee is given a LEAPS number and in a number of offices the Inland Revenue department now accept that number as the man's Inland Revenue tax number.

Mr. H. F. Stevens (*The George Cohen 600 Group Ltd.*): Mr. Hopkinson and Mr. Ryan have provided a marked contrast in their approaches to large-scale A.D.P. schemes. On the one hand, Mr. Hopkinson has said that lengthy feasibility studies and costly development work were purposely dispensed with, whereas Mr. Ryan has described to

us the very exhaustive and detailed G.P.O. approach to the LEAPS project.

To enable us to judge the relative success of each approach, will Mr. Ryan indicate the development costs of the LEAPS project, so far, in relation to the savings achieved? Conversely, will Mr. Hopkinson tell us what was the size of the A.W.R.E. pay-roll project, and what savings were achieved in relation to his presumably much smaller development costs?

The Chairman, Mr. C. P. Marks (*Ministry of Aviation*): On the last point, I must protect Mr. Hopkinson. We cannot expect him, coming from where he does, to disclose figures of that nature.

Mr. W. S. Ryan: Should I quote Mr. Stevens's antecedents? (*Laughter.*) He was a colleague of mine once. I quoted the figure for the postal side. We have actually done a lot more conversion on the postal side and the savings are a good deal higher than the hundred and four I quoted now. We have converted the London Telephonists, we have the Pensions people on, and there are savings elsewhere. I think we must pay our staff rather more than the George Cohen Group because a hundred staff in the Post Office would be paid rather more than £100,000 a year. If I might give the balance sheet very broadly—the computer and peripheral equipment cost £400,000 in very general figures, and the conversion costs will be somewhat around £400,000. The position is that (I cannot quote you an exact figure, I am sorry) the total annual savings at the moment exceed the expenditure per year, so with the backlog to make up it will take us another year or two to show an overall profit.

May I quote an instance of where we have produced an advance for which we cannot claim a saving? I mentioned amongst the items we cover that we do a thing called exchange-line costing, working out the cost of an average telephone exchange. That is a very complex job. To do it manually requires, shall we say, six to eight clerks. That was the job that was being done before the computer came along. The cost of converting it was very slight indeed, one person, a systems-programmer. When he had been on the job a relatively short time the people who wanted these figures realized that they could get a lot more information than they were getting from the old system, and the final costing, which is actually run on LEAPS every week now (it takes about an hour a week), is a far more sophisticated job than the original one. It has been estimated that the staff which would be required to do this job in any other way would be at least thirty in total. When we claim savings in LEAPS we do not claim the thirty, we simply claim the six to eight who were employed on this work previously, so there are hidden savings there.

I do not know if I have answered your question completely, but that is the present picture. We expect to complete conversion of the whole of the LEAPS area, the original area, in, shall we say, 15 to 18 months from now.

Mr. Hopkinson: I can certainly add something to what the Chairman said. If the question had been phrased in a different way I could have made an answer. The standard question is: how many people work at the Weapons Group and the reply is: half of them. (*Laughter.*) But apart from that, we have made real savings. We carry out the payroll for several thousand employees. Recently, we have taken on the payroll requirements of other groups and have actually saved eleven people (say £11,000).

Before we set up an A.D.P. installation one of my responsibilities was stores accounting. I installed a system which really fell flat on its face and subsequently it was the first job we put on punched cards. It saved about fifteen people, but it was such a poor system that it was impossible not to save. The converse is that when we transferred our punched-card pay-rolling system, which was quite good and had been running for about three years, on to the 1401 our savings were comparatively negligible. I think it depends on how good or how bad your existing system is. We feel, and the management feels, that we have paid our way and in addition we have supplied a lot of information which could not possibly be obtained in any other way. Whether this is good or not, I do not know, but we certainly have a whole queue of jobs awaiting our attention.

Mr. J. T. Whittaker (*H.M. Treasury, London*): I want to ask Mr. Hopkinson just one question. We have always been very interested in your achievements at Aldermaston, which we have followed in great detail. You have always kept us well informed of what you are doing. Before you actually put your new systems on to A.D.P. was it in the knowledge that you had at the back of you some very powerful computers which, in any case, would be at Aldermaston, and therefore you were able to plan against that background? Now, in our other government projects we have to justify the computer for the task that is being done and not just add to an existing computer system. Hence very often, apart possibly from the complexity of our tasks which are far greater, probably, than the ones you are doing, these do account very largely for the very difficult and drawn-out studies which we have to make in order to justify first of all the purchase of a computer, and then make it pay.

Mr. Hopkinson: This is probably very true. We acknowledge that we have been very fortunate at Aldermaston on the A.D.P. side. We did take advantage, but we did have courage in the first place, to take advantage of the situation. We planned to be independent, but as time went along we very quickly realized that there was quite a lot to be gained by integrating with the scientific installation, but in a place like Aldermaston the "admin." types and the scientific types are very suspicious of each other. It took quite a lot of good-will and spade-work at working level before it was really accepted. As we have been able to operate our rented computers on shifts, we have therefore been able to take full advantage of the decreased charges for shifts.

Mr. H. W. Gearing (*The Metal Box Co. Ltd.*): Since the Post Office itself uses physical movement of raw data, what provision can be made for suitable priority treatment of company data transmission in mails (at Christmas time, for example), e.g. by provision of *distinctive labels* to those companies which might register for this service in advance, to ensure priority?

Mr. Ryan: I am not, of course, a postal expert, let me make that quite clear. There is an express service available at the moment—I think you might well use that. There is also a messenger service which is still available if you merely require high speed, and in the *Post Office Guide* will be found details of the *Railex* and *Railway Parcel* service.

Mr. A. J. Powell (*War Office, Bexleyheath*): When are speakers planning to replace these most satisfactory computers?

Mr. Ryan: When I described the problem of selecting the name for the first Post Office large-scale computer I had intended, but forgot to say, that we expected to have a fair number of computers in the future. In fact we are now reaching the position of the Royal Flying Corps after the first World War, when they realized they could not remember all the names so they started giving people numbers. Our future computers will be numbered. We are actually in the

process of deciding which computer, or which computers, we are going to buy next. We shall be deciding in the very near future. As for replacing the existing computers, as was pointed out, I think, by Mr. Janes, that case will be dealt with on its economic merits. If we can do it cheaper on the new machine and scrap the old machine, we shall scrap the old machine. If it still works successfully, although it may be obsolescent, as it certainly is if it works, we shall continue to work the obsolescent machine.

Mr. Hopkinson: I am going to say that we have already made up our minds, because if I do not, I know that we will be contacted by all the manufacturers' representatives next week. We are very much geared to the scientific requirements and, as far as we are concerned, at the moment the only requirement is an extra 4K of storage next spring. We are happy then for at least another three months.

Mr. W. F. J. Rowlandson (*Friends Provident and Central Insurance*): Mr. Ryan mentioned that his original timing estimates were doubled and still the final results were double that. Could he give us a little indication as to where all this time did get lost? I expect to have precisely such a problem within the next month or two.

Mr. Ryan: The first estimate of time was that each payee would take three-quarters of a second. This was the manufacturers' estimate, based on their—at that time—very limited experience. We doubled that to 1½ seconds for our estimating purposes, but our first payroll we found took roughly 2½ seconds per payee. It was revised and brought down to 1½ seconds. The reduction in time arose partly out of a systems examination of payroll, noticing that certain things happened with a certain frequency and regularity in a large proportion of cases, in which case it was possible to segregate very early on the "common" and "uncommon" payees, and the common payee is processed in about three-quarters of a second at the moment. That was part of the reason for the reduction. The other part of the reduction arose from optimization of the program—possibly you know that in the 405 system there is a timing problem, and if you get the timing wrong you can be out by a factor of, I think, 16; so by careful attention to the precise time in which an instruction is obeyed you can reduce the overall time very appreciably. These two factors actually produced the reduction, so therefore you can work back and say the cause of the trouble, or the cause of the increase was that we did not do that in the first place.

Mr. C. H. Jackson (*Ministry of Aviation*): Could Mr. Ryan elucidate the work-load statistics he has given?

Mr. Ryan: I am sorry I was not perhaps as clear as I should have been there. The total payroll in London is about 112,000, approximately 80,000 are weekly, the rest are monthly. We are currently working about ten hours a day, but we hope to go into the second shift if it has not already occurred in the last week or so. Is that an answer to you?

Mr. Jackson: Yes, only that is going to more than double the payroll, which means that you are going to be working more than a 24-hour day.

Mr. Ryan: Well, the total load carried at the moment is rather more than 48,000; there are actually 7,500 monthly as well. We have certain gaps in the working day at the moment that we do not occupy.

The Chairman: I have a question that I should like to ask Mr. Hopkinson, particularly when he has run his program on a series of I.B.M. machines. What use, if any, has been made of automatic programming languages?

Mr. Hopkinson: None whatsoever. We have been limited actually in using Autocode. We have not had available until quite recently four tape units on one 1401. We are planning to use Autocode. We are not all that enthusiastic about automatic programming languages because we find that, even writing in symbolic language, most of the staff can code the programs as such very easily. There is no great problem in programming. It is the systems side which takes 90% of the effort.

Mr. E. R. Kermode (*Price, Waterhouse, Peate and Co., Addis Ababa*): Can Mr. Ryan say whether the "increased sophistication" of the costing resulting from use of the computer was followed by a corresponding increase of sophistication in the use made of it?

Everyone who installs a computer boasts of the "additional information produced"—but is it used?

Mr. Ryan: So far I do not think that any direct benefit has flowed from this particular application. I think we shall probably have to wait five to ten years before we can see any real quantifiable saving here, but nevertheless what I said is quite true. I have not claimed any saving for LEAPS for this particular benefit which will accrue. We presume that the people who ask for a facility which the computer can provide are going to make use of it.

Book review

The Application of Digital Computers to Structural Engineering Problems, by D. M. BROTTON, 1962; 183 pages. (London: *E. C. F. N. Spon Ltd*, 57s. 6d.)

A more accurate and only slightly longer title would be "A description of the Mercury Computer and Mercury Autocode and of some structural engineering programs." The first half of the book sets out to introduce engineers to computing. It is difficult to see a beginner gaining anything from the description of Mercury which is given: anyone interested in conventional coding would do better to read the manual produced by Ferranti; anyone with a lesser object would be confused by the details given here. Such things as long and short words and complement arithmetic are discussed. An adequate discussion of Autocode is given, but a reference to Pegasus or 803 Autocode would not be out of place. Such diverse topics as the solution of partial differential equations and numerical integration are despatched in the space of a few pages.

The second half of the book is devoted to structural engineering. Some structural problems are set up in matrix form and two methods of solution are discussed. Present and possible future calculations are considered; emphasis is given to the importance of using computers in conjunction with, rather than instead of, human expertise. Finally erection calculations for suspension bridges are described. All of the topics in this latter half of the book are well covered and they make interesting reading; however, one feels that if the author is going to discuss the future he might give some consideration to Atlas and the KDF 9, and to ALGOL or FORTRAN.

A. HASSITT.