

A Direct Ordering, Recording and Invoicing System

By G. Jennings

The speaker presented a film-strip describing the Shell-Mex and B.P. order handling procedure at the Royston depot of that group. The details have been compiled from an article in *Shell-BP News*, reprints of which were distributed at the meeting. These paragraphs have been reprinted by permission of the Editors of that journal.

Field Trials for New Methods

During the last decade Shell-Mex and B.P. Ltd. has built many new depots and installations. Outwardly, Royston is just another. It is spacious, clean, and sensibly laid out, it has up-to-date arrangements on the gantry for vehicle loading, good facilities for servicing vehicles, and good amenities for the staff—all the features which have come to be associated, in fact, with our modern installations and depots.

But Royston is more than this. It has been selected as a testing ground for some fascinating equipment. Royston is being used for field trials for new methods. Quite probably there will be all sorts of modifications and re-thinking before such methods become general throughout Shell-Mex and B.P.'s distribution system; that is the whole point of field trials. Nevertheless, the significance of these developments should not be undervalued. They are way ahead of anything else in their spheres.

There are two groups of methods under trial. First is the use of equipment for the remote control of all operations in the tank compound, such as the opening and closing of valves and recording dips and temperatures of the products stored. Secondly, there is an experiment called DORIS; the meaning of the name you will read below. DORIS is only a debutante but already it is obvious that she is able to teach us a lot. No other company, in the oil industry, or in any other, anywhere in the world, has produced a creature quite like her.

Remote Control of Operations

At Royston Installation, which is rail fed, all grades of motor spirit, diesel fuels, light fuel oils, and twelve grades of lubricants are handled. The watchwords in planning it were: speed, control, space, and economy. It was designed to give the closest control of the quality and movement of products, from the off-loading of rail cars into storage tanks to the loading of road vehicles at the gantries.

All the handling of the products can be controlled by watching dials and pushing buttons on a master control panel in the manager's office. The dials show the levels of products in the tanks and what their temperatures are, and the buttons operate valves which govern the flow of the products from or to vehicles. The panel is arranged as a flow diagram and light signals indicate



Fig. 1.—General view of the room in which DORIS is housed

which pumps are operating. At the rail tank car discharge position there is a control panel from which all tank inlet valves can be opened or closed, subject to the overriding control of the master panel.

Growth of Business calls for New Methods

In the last ten years Shell-Mex and B.P.'s sales have increased two-and-a-half times. Despite fierce competition, the Company remains the leading oil marketing Company in the country. To achieve this, constant search for more efficient methods has been necessary. This need for increased efficiency has led to an examination of clerical methods at depots. They were mainly manual and repetitive but at the same time the source of most of the Company's accountancy and statistical information. Could the methods be improved? DORIS may provide the answer.

Eighty-five per cent of the Company's customers telephone their orders to our depots. The depot makes up sales tickets and delivers the products. The completed sales tickets, sales summaries, and stock reports are sent to one of the ten divisional offices. At divisions, punched cards are used for sales analysis and for book-keeping machines for customers' accounts. Invoices are typed. Each year the depots make out more than three million sales tickets, which lead to over five million punched cards and one and a quarter million invoices. With the prospect of further trade expansion and the wish for increased efficiency, the possibility of mechanizing the

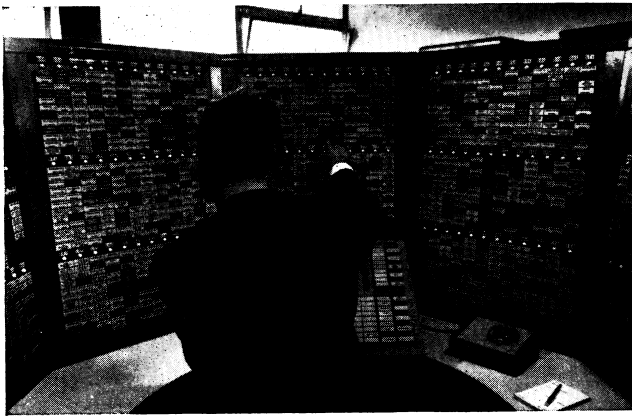


Fig. 2.—Order clerk on telephone, showing three sides of the seven-sided cubicle of the input console

clerical work at depots was examined. One of the main objectives was to create error-free data in a form suitable for later machine processes.

Eventually it was decided that mechanization was possible but special machinery would have to be designed and manufactured. An investigation into ways and means was carried out in conjunction with Creed and Company Ltd. The problem was examined in relation to equipment and cost and it was decided that our needs could be met by electro-mechanical rather than electronic devices. Speed of processing would be adequate by electro-mechanical means and maintenance and staffing problems greatly simplified.

A Description of DORIS

Laboratory models were built to prove and test ideas. Then the prototype equipment was built—the equipment which has been christened DORIS (Direct Order Recording and Invoicing System). From start to finish the task of investigation and building took just over two years. By July 1960 DORIS had been installed at Royston Installation and had started operating. A general view of the room in which she is housed is given in Fig. 1. 85 per cent of our customers order by telephone. The sales clerk, wearing a telephone headset, sits at the input console. This is installed in the seven-sided cubicle which can be seen in the background. Its seven walls are panels of push buttons, all within easy reach and each bearing the name and address of a customer. Three of these walls can be seen in Fig. 2.

There are some 3,000 button positions. Although 3,000 customers could be dealt with by this one console, about 1,500 buttons are actually in use at Royston. The customers' names are arranged in alphabetical order. As soon as a customer telephones, the sales clerk depresses the button bearing his name.

Immediately in front of the sales clerk, at the centre of the input console, is a panel, illustrated in Fig. 3, by means of which he can record all the basic facts about the order as quickly as the customer can give them to him over the telephone.

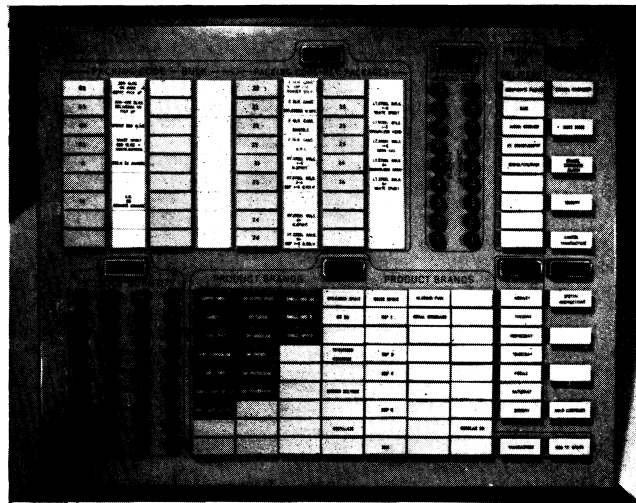


Fig. 3.—Panel at centre of input console in front of sales clerk

On the left of the panel under the words "Product Quantity" a series of numeral buttons record any quantity from 1 to 9,999 gallons. In the centre, under the words "Product Brands," is a series of buttons labelled with the names of products. These are colour coded for quick identification, red for Shell and green for BP. On the right, a row of buttons show the day of delivery, and on the top of the panel other buttons cope with the packing code for deliveries in bulk and deliveries in returnable packages, including the number of such packages, and the method of delivery.

Entering an Order

While the buttons are depressed the clerk checks the order back over the telephone with the customer. He then pushes the "Transaction" button and the "End of Order" button (bottom right-hand corner). The function of the "Transaction" button is to enable the clerk to record an order for several products without re-entering the constant-factor buttons, such as customer and day of delivery. The "End of Order" button clears the input console ready to receive the next order. If the clerk should neglect to insert any necessary piece of information a buzzer sounds and one of the red panels (which appear as black oblongs in the picture) lights up and shows what has been omitted—for example, "Insert day of delivery."

Obviously special instructions about delivery will sometimes be requested. The clerk makes a note of the request on a scribbling pad and presses the "Special Instruction" button. This causes an asterisk to appear on the delivery ticket, which shows the routing clerk when he gets it that there is a special delivery instruction of which the sales clerk has a note. When the clerk presses the "Transaction" and "End of Order" buttons this is the last manual operation required to enable DORIS to produce sales tickets and invoices.



Fig. 4.—The summarizer which adds up the daily issues, etc.

All the information about the order, recorded by pressing the buttons, is perforated on paper tape. As this takes four seconds and the average telephone call takes fifteen seconds, there can be no delay in handling orders. Subsequent processes are slower than the initial recording time and therefore a magazine is provided under the table to hold the overflow tape. The tape is read automatically and production of the issue document now begins. The first step is to obtain the full information about the customer and product. This is stored on reels of seven-channel strengthened paper tape. Five channels are used for normal letters and numerals, punched in CCIT code, the sixth is used for machine control codes, and the seventh for customer-record block identification.

For convenience in handling amendments and speed of processing, each customer's information has been split into static-address details and terms-of-trade details. These are stored on separate reels, 500 per reel. At Royston, with 1,300 customers, there are three reels holding addresses and three reels holding terms of trade. One reel suffices for the product details. Spare reels are also provided. When the input reader mechanism identifies the customer number, the tape reels are revolved at high speed—45 ft per second. The seventh channel holes are counted by a photo-electric cell until the required customer information is reached. The reels are then stopped and printing of the sales ticket begins. When the input reader mechanism identifies the product required, the product details are selected similarly from the product store reel.

The description and price of the product are printed on the sales ticket, and the value of the total order

worked out. Both sales tickets and invoices are printed simultaneously on these Creed machines. Thus the first things that DORIS produces automatically are the sales ticket, which is passed to the routing clerk for briefing the driver of the delivery vehicle, and the invoice for the customer. But she also has another function, which is to make a permanent record of the orders, for all the subsequent accountancy and statistical processes needed by the Company. At the same time as the sales ticket and the invoice are being printed, therefore, the information required for summarization of the day's transactions at the depot is punched on perforated tape on a Creed tape punch/interpreter. To assist identification, the serial number of the sales ticket is automatically over-printed on the tape, which is then held in a storage rack until delivery has been made to the customer.

Summary and Analysis of Sales

When delivery has been made, the tape is fed into a summarizer (Fig. 4) which has several functions to perform. It adds up the daily issues for each product. In addition, it has to sort the sales ticket information into punched-card format and reproduce the information in this sequence on another punched tape. Thus during the day it is producing punched tape containing details of each order, and at the end of the day a printed record of the daily issues together with a punched tape record in both punched-card form and in an abbreviated form from which stock summaries are prepared.

The detail and summary tapes, together with the printed daily summary of issues and values, are sent to the divisional office. Here the tapes are fed into a tape-to-card converter so that the cards may be used in the existing Hollerith machinery. Thus returns from the depot can be rendered in the form of paper tape, which can itself be processed by mechanical means (when converted to punched cards), or, if necessary, by electronic means. DORIS has recorded accurately all the facts about each sale at the moment the order was given, and from these basic facts flows all the accountancy and statistical information which the Company requires to run its business.

Conclusion

So DORIS makes her bow. The experts describe her as "an experiment in the field of integrated data processing." How she will develop we do not yet know, but we may salute her as material evidence of Shell-Mex and B.P.'s constant search for better methods.

Summary of Discussion

The Chairman said that in addition to Mr. G. Jennings, a senior member of Shell-Mex and B.P. Ltd., who was concerned with systems planning, they were privileged to have Mr. Billett, an expert on the technical side. Between them they hoped to cover all aspects of DORIS.

The system was an experiment to see if the clerical work in the industry could be mechanized with the object of automatically processing the sales transactions in a form suitable for subsequent machine processing. That would appear to follow logically upon the previous session.

A film-strip showing the conception, construction, installation

and operation of the DORIS system was then shown. The substance of this demonstration is covered by the paper printed above.

Mr. G. Jennings (*Shell-Mex and B.P. Ltd.*) said it should be emphasized that DORIS was an experiment. There might appear to be a lot of equipment to do a simple job.

Mr. Tantrum (*I.C.T.*) said it had taken many years for a company like Shell-Mex to develop the idea of DORIS. The principle of pre-selection has been developed by Shell-Mex. What factors had compelled those responsible to use this principle?

Mr. Jennings said a study of the efficiency of the offices had shown that they could not be improved by normal methods and known management systems. The only solution appeared to be to find some form of machinery which could bring greater efficiency.

On pre-selection, normally all orders were written on paper. Having made the entry on the order pad, the clerk had to take a delivery instruction card and prepare invoices or tickets. It was desired to deal with the customer on the telephone and also deal with the actual order without avoidable delay. Otherwise it would have been necessary to turn to an index and check the name and send through the information. That introduced many possibilities of error and absolute accuracy was aimed at, at the source and onwards. Also, it was desired to get information which could go forward for systematizing on punched cards or a computer.

Mr. F. C. H. Witchell (*Pressed Steel Company Ltd.*) said the storage of information on paper tape appeared to be a relatively slow and clumsy method. Why was that selected in preference to other forms of information storage?

Secondly, it was generally known that any movement or action by a human being was liable to error. Noting information by hand, depressing keys or operating switches all introduced a liability to error. How did the error-rate of the push-button system of control compare with that on key-punching or typing? What facts were available on that? Had records been kept showing that, for any psychological reasons, there was any effect in removing the possibility of error on the part of the human operator?

Mr. Jennings, dealing with the first part of the question, said it had been purely a question of cost. At the start they had approached every machine company and computer manufacturer. At that time only full-scale, expensive computers were available.

They had then approached Creed & Company. There had been no need for great speed in operation. A rate of one ticket per minute was adequate. With electronic operation one got high speed and high cost. Paper tape had been chosen largely for those reasons and also because of ease of storage. There was a new store coming along which would use paper tape, which would be easy to maintain and operate.

As to the error rate, when the operator had depressed the "Customer" and "Product" buttons he could see that he had depressed the right ones. The error rate had been found to be negligible. It was essential for the call-back—as would be done over the telephone—the information being repeated by the operator. That largely removed the possibility of error.

Sometimes it was difficult to get the customer's name and it was necessary to ask for it two or three times; and it was necessary to educate the customer to give his order in the correct sequence. Over all the system worked well.

So far there was nothing to provide the kind of information required from computers and it meant having an army of clerks or using punched tape and cards.

Mr. F. J. J. Johnston (*British Iron and Steel Research Association*) asked whether the system required the use of a telephone operator, and did any problem of queuing arise, when a number of customers were telephoning into the depot at the same time?

Mr. Jennings said there was no queue problem. The average telephone call took about 15 seconds and the recording time was 4 seconds. Originally they had considered installing a three-line holding device but it had been found unnecessary to do that, although it might be required in a very busy centre. However, that would entail the provision of another console and another operator. At the present time there were 1,500 potential telephone callers, but the order-frequency in the dealer trade meant perhaps three orders a week. It was exceptional to get a customer-order every day.

With commercial consumers of fuel oil the pattern was the same, although some might want fuel every day or every other day, while others wanted weekly or monthly deliveries. At a place like Royston, with 1,300 customers, there were 150 sales tickets a day which gave an indication of the numbers. At a bigger place, like Fulham, the number of customers was perhaps 8,000 to 10,000 which could mean 800 orders a day.

The target was to get 400 orders a day from each piece of equipment; and he believed that that was possible.

Mr. J. L. Bradby (*General Post Office*) said in the light of what had been said—that there was no especial need for speed—why had the company gone ahead with a system of that kind instead of a more conventional system like the Flexowriter; and could he say what the economy had been in relation to the capital cost involved?

Mr. Jennings said when the project started the Flexowriter system was hardly in existence. The only one then in the country was for sending circular letters. Again, if they had used the Flexowriter it would not have been possible to capture the order quickly. It was not easy to refer to a punched card while speaking to a customer on the telephone. Further, the overall expense in using the Flexowriter system to do all the work they had wanted done would be comparable to the cost of the system they now had, which was much faster.

This had been an experiment to determine whether the job could be done as an automatic office system. At the time it had been considered to have a pay-off, and that was still the view. It was a sponsored project. He believed on the actual production job they would work out economically; in fact, his company were convinced they would. Then there were intangible things. If the company could get supplies to the customers out more easily and more cheaply, that was an advantage; and the punched tape output could be sent to the computer overnight and the vehicle routing would be back by the following day. At present that was done by hand and there was room for improvement. Again, with a quick order one could check the stock run-down in advance.

Again, if one took a particular area, say Shellhaven, on the east side of London, to Walton in the west, it was quite possible that all orders from that entire area could be handled by one order office in London. At present there were eight operating points. There would be great advantages in having a single order office.

Mr. J. J. Sharp (*IBM British Labs.*) said it was stated that one tape from the machine using the summary went to the punched-card system. What was the difference between that and the other tape? Also, how was the sorting performed, and what was the purpose of that?

It was said that invoices were extended somewhere in

relation to amount and cost, to give a total. How was that extension made?

Mr. Jennings said it had been necessary to fit the summarizer in, as an experiment, with the ordinary system in operation and they had had to re-hash the sales data on the ticket which was on the punched tape into the sequence required for the following punched card. At the same time they had had to put in about three extra items of information which could be inserted only at the summarizer stage.

Mr. R. W. Billett said in getting the extension they used four units. The first contained the basic price of the order, the second was a decimal converter, for converting the price into decimals of shillings and pence, which was a form easier to multiply by the gallonage, so that they had the multiplier which took data from the tape and gave the multiple tape, which was the extension fed by the printer to the subsequent equipment.

At the same time the extended price was passed to the totals register, which stored the transaction prices so that, after build-up, they got the total price on the tickets.

Mr. A. E. Grist (*Associated Electrical Industries*) asked whether the present system covered only commercial users or domestic fuel users as well. It was appreciated that commercial fuel users and the system of tied garages meant a fairly static customer list which would not present difficulties arising from additions and deletions; but with domestic users there obviously would be difficulty.

The problem with punched paper tape is keeping the customers in alphabetical order to agree with the display board for identification and use by the operator.

Mr. Jennings said domestic fuel users were not kept on the console. Those were not handled direct by Shell-Mex and B.P. Those customers would deal with the authorized supplier who was the company's agent, and he took the order and delivered the fuel.

With regard to additions, there were, on each console, all the dealers and commercial trade, the coach trade, the haulage people, factory users of fuel oil and so on; and substantial alterations were involved—for example, in dealing with the education committee of an entire council.

All the buttons on the front of the console could be detached. On the reverse side, the customer's actual machine number was shown on a small tagboard. In that respect the system was completely flexible.

Changes occurred at the end of each month—approximately 300 a month. It would be appreciated that at present in the oil trade there was extremely keen competition and there could be a number of changes among consumers. They had been able to handle up to 300 changes at the end of each month, those being received almost at the end of the month, operative usually from the first day of the following month.

Mr. M. Crowther-Watson (*Special Projects Branch, I.C.T. (Engineering)*), asked whether Mr. Jennings had considered using the punched card as the final instrument of control of the actual loading of the vehicles with various grades and quantities of fuel.

Secondly, how long did the paper tape last in the Paper Tape Store before it wore out?

Mr. Jennings said while experimental work was being done on that at Royston, any system adopted would employ not punched card but punched tape. There was a system employed in America where jobbers came in with 5,000-gallon vehicles for one, or occasionally two products, whereas his own firm might send out three products on one vehicle. The gantry loading required for that was difficult to arrange.

That system could be operated for just one product, but the orders received at present might be for 200 gallons or 4,000 gallons, and might cover three products and it was not easy to get those on.

The paper tape was of specially strengthened grade and very tough. As the tapes had to be changed monthly there was no problem of wear. In the early days of the system, before the transport mechanism was perfected, there had been some tape breakages; but as long as a tape lasted for one month, that was all that the system required. On one store this type of tape had been satisfactorily run for three months.

Under the new system there was no snapping or wear and the tape was operating at 80 ft per second, using ordinary paper tape.

Mr. J. W. Mitchell (*The Rank Organization*) said he was under the impression that having produced the necessary document, the analysis of the information took place after delivery. Had the problem of vehicle scheduling been considered? Also, had they considered the possibility of forecasting sales, for stock-purposes, at an earlier stage, based on the information recorded on the paper tapes? If that was not done, how did they carry that out?

Mr. Jennings said the vehicle routing was entirely manual. On each ticket the actual location of the dealer or commercial consumer was shown, and routings were operated from a large board. Trips were entered on the board with a wax pencil and at about 4 p.m. the operator proceeded with the vehicle loading.

It was foreseen that in the future, after the orders were recorded for the following day on punched tape, it might be possible to produce, at the same time, an extra tape which could be sent, in the evening, to the computer centre to enable allocation of vehicles in the ideal pattern. There was some slight danger there, for example, when a seaside resort was being supplied, there might be an order for 1,000 gallons to be delivered on a Monday morning, because the dealer there expects to sell out over the week-end; but if the weather is wet and his sales are poor, the vehicle sent out with 1,000 gallons may bring back 500 gallons which were found on arrival not to be required.

Those were fringe difficulties but it had been shown that there could be a computer application under a central system. That had come about, though, only since the advent of the computer. At the same time, they got the stock run-down in advance. The problem was not too great because there was now almost three days' supply at each installation, with other stock "in the pipeline".

Mr. C. P. H. Marks (*Ministry of Aviation*) asked what procedure was adopted with information not required for immediate use but which had to go to suspense-filing. What technique was adopted for dealing with such information, and how was it filed? Was the tape cut and hand-sorted and then extracted when the order went through?

Mr. Jennings said the orders were taken as they came. The working of the supply system involved delivery of spirit the day following ordering, and delivery of fuel oils within 48 hours. Orders were dated as they were received at the console and the final ticket bore the delivery date. Those tickets were retained in date order, while the output tapes were stored in a small rack. After delivery the invoice number was checked, with the big stamp number on the tape. An extra copy tape was held in reserve.

Mr. Billett said when tapes were stored there were two duplicate tapes and a stock tape could be reproduced without interruption of the office working. In the tape service unit,

Creed readers, perforators and teleprinters were used: the paper tape was read by the 92 Readers, the codes being compared to ensure they were the same, and also to check the actual machine. At the same time the solenoids on the 25 perforators were compared to check the code. If the codes agreed, the code was then perforated on to the tape to replace those held in reserve. There was a counting mechanism on the service unit, enabling them to find, automatically, the correct block for amendment.

At the same time, within a block of information, say a rebate, there was an address code and the machine would find the point at which the amendment was to be made. The equipment then stopped automatically, the operator switched to the keyboard and typed in the information, then carried on setting up the next customer-number for amendment.

The speed was about 12 characters per second and there were facilities for comparing the finished tape with the paper tape to ensure that they were identical.

Mr. Jennings added that if there was an alteration in the details relating to a customer he would be given a new machine number which was put at the end of the tape.

Mr. G. W. Shephard (*General Post Office*) asked what was the reliability of the equipment and what arrangements were made during periods of breakdown.

Mr. Jennings said he must speak frankly about the reliability of the machine. It was an experimental model built in just over two years, from scratch. They had anticipated trouble, and they had got it; but it had always been possible to clear the day's orders in a day, even with overtime working. Future models would be very streamlined.

With regard to breakdown periods, orders were always taken for the following day, or the day after that, and they were able to get the orders out in the day. During breakdown periods there was no trouble at all with the input side.

If there was a hold-up in the processing equipment, that was caught up before the end of the day. The most essential thing was to get the order on to tape. If there was a complete failure the information would have to be hand-written; but they had never yet had to do that.

Mr. L. R. Crawley (*S.T.C.*) said he had noticed that orders were cut up and put into a holder. Presumably this had something to do with the possibility of the actual order differing from the initial order, but how could those be put into the summary tape? Did they have to feed each order tape in by hand to get the summary tape?

Mr. Jennings said alterations to the tape were very unusual—of the order of not more than 3%. They then put through an order for the correct quantity, scrapping the original punched-tape output, and put the new one in. The new and old documents were then stapled together for audit purposes, which worked satisfactorily to everyone.

Invoices did not go out until the driver actually returned from the delivery bearing the document signed by the customer. It was intended in future to put on the summarizer the correct quantity, and as the tape came through they would produce a new tape. That would be simpler than putting through a new ticket.

Mr. A. E. Grist said it had been stated that this was a sponsored project. Would the equipment be available to business generally?

Mr. Jennings said he believed that that was the case. At the moment his organization had an agreement with Creed & Company that the first machines were theirs. Afterwards it would be thrown open to all who needed it. That would

bring down the overhead and production costs; but his firm wanted first choice and had a "gentlemen's agreement" with the producing firm to that effect.

Mr. N. H. Tantrum (*I.C.T.*) said he assumed the reference was to the Creed Model 2000. Would the speaker confirm that the DORIS console unit would also be made available commercially?

Could any indication be given of likely delivery dates?

Mr. Jennings said it was fair to state that the system would be made available with the input console and the summarizer; but of course each person would want the summarizer for a particular purpose. If a console was operating on a store system they would be dealing with items rather than customers. The system could be altered to suit particular needs; but the understanding was that if a system was asked for, it could be supplied.

Delivery dates would have to come from Creed & Company but they were now working on an improved version which it was hoped would be completed by about the end of June of the present year. Delay had occurred with that. It had been hoped to get the final production figures by the end of May but delay had arisen over computer decisions.

Mr. W. W. Jackson (*The Metal Box Company Ltd.*) said it had been mentioned that the upper limits of orders per day was 400 on one of those pieces of equipment. What were the limiting factors, since it took only 16 seconds, apparently, to record each order. On that basis one would expect more than 400 orders to be handled in a day.

What was the amount of breakdown, or other restricting factor?

Mr. Jennings said it depended on the number of orders one got from a certain number of customers in an area. They had 1,300 at Royston and got 150 orders per day. That kind of pattern existed throughout their trade, although it was a slightly higher figure in London.

The 400 figure was geared to a large depot, where that many orders would be coming in, dealt with by one operator. It was the end result that his firm wanted—the production of the final ticket. The 400 a day was the target figure for orders.

The day could be extended, which would mean an extra 60 sales tickets for each hour of working. One had always to allow for occasional breakdowns and for the operator's lunch-time so that while it was an 8-hour working day, it was sometimes extended up to 12 hours. An order clerk came on duty at 7.30 p.m. and the other went off duty at 8 p.m.

All that was required was to produce one ticket cheaply per minute. That was the specification and the firm were quite happy with that. With a large installation, like that at Avonmouth or Hamble, some 300 to 350 tickets a day were dealt with. A big jump was entailed when one sought higher speeds. The costs rose sharply and that could not be met economically. The machine must be a standard one, operating at a speed adequate for the firm's needs.

Mr. A. R. Rider (*Bulmer's (Calculators) Ltd.*) said that since the start of the experimental work there had come on to the market the telephone-answering machine and the Friden Flexowriter; and there were similar machines available now. Why had that type of device been rejected?

Mr. Jennings said they had preferred to retain an operator to speak to the customer. The idea of getting the customer to record his orders on tape had not been favoured. It was really a question of company policy. It had been put forward and rejected.

With the Flexowriter and similar machines it was extremely difficult to get the order or refer to the punched card having

on it the actual details, at the speed at which orders were taken over the telephone. There was always the chance of getting the wrong card. There was a strong preference for the console system.

Mr. Rider observed that with the telephone-answering machine there would appear to be no urgent need to get the information on to another machine. There would be a buffer between the call and the input medium to the system.

Mr. Jennings said that idea had been considered. At one time they had had some six recorders available, but they could not see the necessity of a second attempt at getting an order into the machine. It was quicker to take it over the telephone; and immediately the operator plugged in, that was done. Otherwise it meant listening to the recording and then plugging in. The recorder would have meant having an unnecessary intermediate stage.

It was fair to say the experiment was a success. There were some problems involved but they were now quite confident that they would be able to go ahead with the present system. There would be some streamlining in future models, particularly in regard to the rebate aspect.

If they were to continue with the ordinary manual system it would not be possible to achieve the desired degree of integration and they would need a machine of some kind so that orders could be recorded and afterwards dealt with in any way desired. Other systems would entail unnecessary delays. Also, with vehicle routing some such information was needed.

Experiments would continue towards a more streamlined version.

The Chairman said it was always very helpful when the theoretical could be translated into the concrete and everyone appreciated the opportunity of firing a succession of shots at Mr. Jennings and Mr. Billett who had been responsible for the initial work in the experiment.

The number of questions that had been put indicated the great interest taken in the experiment as a whole. It was always disturbing to hear comments and criticisms of work one had originated, but that always happened to pioneers. The appreciation always came a long time after the criticism.

On behalf of those present he warmly thanked Mr. Jennings and Mr. Billett for having provided the filmstrip and answered the numerous questions.

Book Review

Analogue Computers, by I. I. ETERMAN, 1960; 264 pages. (Oxford: Pergamon Press, 50s. 0d.) Translated from the Russian.

This is a book which will interest not only analogue computer specialists, who may find the use made of the methods of numerical analysis helpful and perhaps new to them, but also others with a general concern for computations.

It describes in mathematical terms the characteristics of analogue computing devices, their limitations and imperfections, and also the sorts of problems for which they are appropriate and the known methods for putting problems into suitable forms for analogue computation. The style is easily read, but the information is condensed, and the book requires some acquaintance with the mathematical methods, or with the physics of the equipment, and preferably with both.

The cost of this book has been kept down by using photolithography and offset typescript, which has resulted in rather poor reproductions of the photographs of Russian computers, but the script is acceptable. The mathematical layout and notation are good, but not without errors and misprints.

Chapter I deals, in a mere 22 pages, with the basic concepts and properties of dynamic systems. Practical examples are used to demonstrate the techniques of idealizing the problem, introducing a finite number of discontinuities to a nominally continuous system, boundary problems, existence and uniqueness of the solution, and so on.

Chapter II describes the mathematical properties of circuit elements both mechanical and electrical, linear and non-linear, and shows how functions of many variables must be treated by approximate methods.

Chapter III is something of a *non sequitur* which introduces us by informative thumbnail sketches, together with inadequate and poorly reproduced photographs, to several Russian analogue computers. However, this information is worth

while in itself, and a second part to this chapter gives useful descriptions of certain fairly general operational procedures with reference to the detection of setting-up errors, etc.

Chapter IV surveys some problems which can be solved on analogue computers: the solution of linear equations, the calculation of the eigenvalues of a matrix, initial value and two point boundary value problems for ordinary differential equations, Laplace's equation for two space variables, the heat conduction equation and the wave equation for one space variable. The methods used are, in general, standard methods of numerical analysis adapted for use on analogue computers.

Chapter V discusses a number of methods of finding the errors in results due to errors in the initial values and errors in the function and computing units. A number of mathematical methods are given, among them the Adams method for solving differential equations and the method of integral characteristics for equations with constant coefficients, which can be used if a digital computer is available, and Lyapunov's method, which would seem to be of mainly theoretical interest. Other methods are given where the analogue computer itself can be used to calculate the errors; the errors for a linear system with coefficients dependent on time can be calculated in this way. Some of the methods require additional equipment. Opinions will vary on the practical value of some of this theory to analogue computing, but the book is not deliberately impractical. There is a short discussion of random errors and non-linear equations.

A number of tables are appended of various merit, and there is a bibliography of 43 references, mainly Russian.

It is useful to have this compendium of methods in a compact form, and the survey of Russian work.

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