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 routeing 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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