though no more than three levels within a record were apparent in the files being studied. As a result, the methods of accessing and keying the records can be quite complex, but the advantage of doing so can be judged by the fact that in practice one policy record can be more than ten times as long as another. This variation is unusual but must be provided for. Fixed-length records would thus waste about 90% of the magnetic tape available, and increase overall processing time to an unreasonable extent.

Conclusion

Financial records, which form a considerable part of the general data-processing problem, can be separated by normal double-entry book-keeping into individual accounts, each for a specific asset, customer, or supplier, etc. Each of these accounts can be allotted a serial number, and will generally also contain the next date on which an action must be taken if the account does not alter, subsidiary keys such as the agency involved, the occupation or industry of the account holder, etc.,

the name and address for correspondence, and details both of the items forming the outstanding balance of account and of the contract underlying the account, or each item of it.

The general layout of a record of an account should be arranged with the fixed-length items at the beginning and the items subject to frequent change at the end, as follows:

1. Record separator or length of this record.
2. Principal keys, the account number and the earliest implicit alteration date.
3. Subsidiary keys and statistical keys.
4. Variable-length items subject to occasional alteration, such as name and address and possibly contract details. Void items may be fairly common in the latter.
5. Repetitive items subject to frequent change normally by addition or deletion. The items forming the balance of the account together with their description and due dates are the principal category under this heading.

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Book Review

Modern Control Theory, by J. T. Tou, 1964; 427 pages. (Maidenhead: *McGraw-Hill Publishing Company Ltd.*, 112s. 6d.).

A decade ago, ideas in control theory appeared to be in the doldrums. Linear techniques for design and analysis, firmly based on the Laplace and Fourier Transforms, were highly developed and provided adequate cut and try methods for control engineering design. Attempts to apply transform techniques to non-linear and multivariable systems had been pushed as far as they would go and an apparent impasse had been reached.

It was no doubt the growing ease of numerical computation which sparked off the revolution which has since taken place in control theory. Going back to the original differential equations of the system and facing the difficulties they presented led to the rapid development of techniques based on the variational principle of mechanics, which provided a well developed mathematical basis for the design of optimal control systems. This led to the state space concept and to the principles of optimality as expounded by Bellman and Pontryagin.

This book is one of the first texts dealing solely with these

new methods of design and analysis. It is written for the engineer rather than for the mathematician, and contains a chapter on the necessary mathematical foundations of the subject, *e.g.* set theory, vector spaces, and vector matrix differential equations. The book covers the topics of state space and state transition methods, variational calculus, dynamic programming and the maximum principle. A final chapter is entitled "Computer Control Theory". This is not quite so comprehensive as it may sound, being concerned mainly with the application of dynamic programming techniques to linear systems, but including the case of inaccessible state variables. Such practical topics as computer storage requirements are not discussed.

Many examples are worked throughout the text and this certainly adds much to the value.

As one of the few books on the modern theory, this volume will inevitably attract the attention of the practising control engineer who is trying his best to bridge the much discussed gap between control theory and its industrial application. He will not be disappointed, and, as a bridge across the gap, the book must be given full marks.

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