comparing the net present value as shown in Table 5. In this case, because the largest cash outflow for internal data processing will occur early in the eight year cycle under study and the investment opportunity for those funds is lost for a greater period of time, the cost of service bureau processing will actually be *less* by a present value of $57,140.

Our approach to this decision making process was in three parts; first, the gathering of facts and figures to support dollar amounts of data processing costs *and* benefits; second, the analysis of cost versus benefit for the new applications; and third, the analysis of service bureau versus internal data processing costs. Threaded through the analyses was the application of present value analysis. This technique provided for the determination of the true costs of capital by comparing unequal cash flows in each alternative.

Naturally, overriding the final decision to be made by the utilities management were factors such as risk, desire for management control, prestige, etc. But these factors were only applied *after* the financial analysis had clearly indicated the dollar value gain or loss to be made as a result of the final decision.

Book review

Minicomputer Interfacing edited by Dr. Y. Paker, 1975; 279 pages. (*Miniconsult*, £9·00).

This is a volume of Proceedings of a three-day course at the Polytechnic of Central London, 27-29 March 1974. It forms part of a set of such proceedings, some of which have already been reviewed in this Journal.

It is not easy to write well about interfacing. Because there is a wide range of computers and an enormously wider range of peripherals, interfacing each to each, piecemeal, provides the possibility of a great number of individual designs. Each individual design may need to encompass a range of devices from push-buttons and relays through to whole plants. They may be standard or non-standard, near or remote, serial or parallel, synchronous or asynchronous, analog or digital—you name the possibilities: someone has probably solved the problem at least once. There are immense opportunities for reinventing the wheel. A book on interfacing, therefore, is apt to contain a set of special designs of little interest to the student or general reader, or it is likely to be so generalised that it is merely platitudinous. The organisers of the course which gave rise to these proceedings obviously thought a great deal about this problem for they have effectively produced a solution avoiding either extreme and have produced a document which many people will be able to study with profit.

The first paper is introductory, by Dr. Y. Paker, the editor of the proceedings, and is necessarily general. It covers, in twenty-five pages the whole topic in perspective—description of the task, the nature and operation of the minicomputer, operating systems, difficulties—with considerable clarity and elegant brevity; it is well in the tradition of the introductory lectures of the other proceedings of the series, which is to say, it is good. There follow five papers on the general problem and five on more particular solutions to it.

Since the proceedings are of a course rather than a conference, the general papers divide the subject up conveniently. The first is by M. W. Shawyer of Data Laboratories and deals with Analog Interfacing in forty pages, without leaving anything out that matters. The principles are well enough described for the general student, yet there is adequate detail to point the way to someone actually faced with the design problem.

Digital interfacing by T. Luffman of Instem briefly introduces the basic concepts of typical digital interfaces, serial, parallel and highway arrangements, multiplexing and the like, together with words of wisdom about choosing the right mini in the first place.

Interface data transmission by K. Boydell of Kent Automation Systems provides a compressed but clear description of the telecommunications aspects of interfacing. The paper includes useful tables and graphs demonstrating the merits and limitations of the available techniques. This is a most useful paper to a potential, or practising, interfacer since it distills out for the reader a necessary minimum of appropriate material from the redoubtable mass of telecommunication theory.

Minicomputer interface hardware by F. S. Ellis of GEC Computers, rounds off the general hardware section with a brief survey of the hardware strategies available—interrupt techniques, handshakes, bus and star systems and the like. It is general, but in sufficient depth to be useful.

The software aspect of interfacing is also a difficult topic to handle generally as well as usefully but A. M. Kermode of Logica achieves it by the neat approach of writing his paper in the form of a conducted tour, to use his own phrase, which he accomplishes in thirty excellent pages. The author starts with basic principles, describing and defining the techniques and their purpose; he builds up a comprehensible system structure which is simple enough for the non-software expert to follow. Having defined what needs to be done he then outlines the approach to doing it. Perhaps, because I am fundamentally a hardware man I find myself drawn towards liking software experts who really do understand hardware and who can explain their own art to engineers: anyway, I like Kermode's paper very much. It contributes a necessary ingredient to the overall coverage of this book.

In the customary pattern of good teaching practice the general exposition should be followed by illustrative and educative examples. Much art lies in the choice; in interfacing there is a great volume to choose from. The course organisers have chosen five wisely and well in my opinion.

The first application paper, by D. A. Seale of Micro Computer Systems, is entitled Interface design, which it does indeed describe. The paper goes through the successive stages of a design, the approach, the specification, 'costs and trade-offs', and then demonstrates the method applied to a data acquisition system first and illustrates it further with a numerically controlled machine system. This paper properly stresses the importance of maintenance considerations at the design stage.

Appropriately the next contribution describes a successful attempt to produce, by design and agreement between organisations a standard interface. R. C. M. Barnes of UKAERE Harwell describes in detail, with specifications, the CAMAC Interface system. This provides a good explanation of the principles of the CAMAC system as well as being a useful reference document. There are two papers which support the CAMAC paper. The first, Interface design constraints by the late B. E. F. Macefield of Oxford University is a closely reasoned progression through a typical design which leads logically to the CAMAC solution. The second, a CAMAC system for satellite check-out, by A. R. Rundle of Logica, provides an excellent illustration of the use of CAMAC.

The remaining paper is by P. Kellard of CERL: On-line data analysis and control: it is a detailed and thorough exposition of the instrumentation and control by minicomputer, of a very complex test rig. It is a truly illustrative example of the art, or science, of interfacing, competently and well designed and described.

In conclusion, this is an excellent volume dealing with a difficult subject well. Each paper is followed by a chosen bibliography. Anybody threatened with the possiblity of designing an interface would do well to read it.

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