problems, and in helping it to react rapidly to changing circumstances. It is perhaps right to lay some emphasis on this aspect of the use of computers. Not only can they assist by rapidly producing approximate answers to problems in transport and production, but also they can provide statistics concerning the internal operation of a business—cost analyses, demand analyses, stock levels and the like—on a far more up-to-date basis than is normally possible with other methods. It would seem obvious that this service is of value to business, and yet it is hard to put a price on such considerations, and sometimes difficult to decide what the existing service costs the firm in any case. For this reason it is often a factor which is largely omitted from economic computations on the installation of a computer, and yet it is, perhaps, one of the most significant factors in favour of mechanical accounting.

In the United States many firms are already well set upon the road to accounting by computer, and much thought is being given to the use of computers as an aid to management. In this country we are still taking our first tentative steps in the same direction. A speedy and successful transition to the new medium is thus, in my view, essential. This can be achieved only by a forward-looking policy on finance and by close co-operation between manufacturers, programmers, users and potential users of computers. It has been the aim of these articles to indicate where and how I think computers can most usefully be employed in commercial undertakings. As a somewhat personal view it is, of course, open to criticism for its content and emphasis. Be that as it may, I shall be well content if I have served to bring all concerned to think critically about the problems of the others.

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Correspondence

The Principles of Sorting

Sir,

Mr. Venn correctly remarks (1958), but only as an aside, that the variability of an r-state system is $r - 1$. If you have but one thing, you have no alternative; the system is either rigid or inexorable. There are $r - 1$ gaps, not r, between r lamp-posts; any and every point on a line or conductor is a one-fold branch or switch, which is therefore costless as well as useless for any operation involving choice.

The change from r, the number of states, to $r - 1$, the number of alternatives or degrees of freedom, is not trivial. The function $(r - 1)/\log r$, r being taken as a continuous variable, has neither discontinuity nor maximum nor minimum, but rises monotonically from zero as r goes from zero to infinity. It therefore gives no aid or comfort to those who, like the introducers of the aberrant $r/\log r$ in the late 1940's, wish to revive Leibnitz's mystique of the binary radix.

Over twenty years ago Couffignal (1936) used the parameter $(r - 1)/\log r$ to prove correctly that, if one were confined to integral radix, the scale of two demanded less mechanical complication for the representation of numbers than did any higher radix. He did not claim it to be the "best" for this or any other purpose.

I myself (1953) interpreted this parameter as the average variability or complication of a system required per unit of selective information, and generalized r to cover non-integral values, and therefore to include analogue and variable word-length representations. To wit: $\log r$ is the average selective information per digital site, the average being taken over the vocabulary of words or operations. In this paper I indicated the application of the parameter to sorting and marshalling, and to facsimile printing of output. Various later papers of mine have developed the theme. (Fairthorne, 1955, 1956.)

This measure of inherent complication, though a basic parameter, is by no means the only important parameter of even a simple clerical system. Nevertheless, unlike $r/\log r$, it is not a patently absurd one.

Yours truly,

Farnborough, 19 *October* 1958 R. A. Fairthorne

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