Pollaczek-Khintchine formula (see Lee, 1968, page 34). We have

$$N = \tau^2(1 + c^2)/2(1 - \tau) + \tau , \qquad (4.1)$$

where c^2 is the coefficient of variation, and τ is the traffic intensity of the queue, given by $\tau = \lambda'/\mu^*$ or

$$\tau = \lambda'/(\mu - \alpha(14\lambda')) , \qquad (4.2)$$

where $\lambda' = \lambda/14$. The parameters μ, α and c^2 were estimated from performance data using the nonlinear regression program of the Biomedical Computer Programs. The performance data were collected through a file collector package and related module queue sizes to input rates. The independent variable was the input rate λ' and the dependent variable was the module queue size N, which except for random fluctuation in N, was related to λ' by expression (4.1). The estimates obtained were: $\hat{\mu} = 20\cdot42$, $\hat{\alpha} = 0\cdot058$ and $\hat{c}^2 = 1\cdot00$. The residual sum of squares was $0\cdot098$. A line printer plot of λ' versus the predicted and observed variable N is given in **Fig. 3**. A plot of the predicted variable N versus residuals is given in **Fig. 4**.

In the light of these estimates the following simpler model was tested. Parameter α was taken to be equal to $1/14$ ($= 0\cdot07$) and c^2 was taken to be equal to one. Expression (4.1) was then reduced to the following simple expression

$$N = \tau/(1 - \tau) , \qquad (4.3)$$

where

$$\tau = \lambda'/(\mu - \lambda') . \qquad (4.4)$$

(Expression (4.3) gives the mean number of units in a $M/M/1$ system.) The obtained estimate was: $\hat{\mu} = 18\cdot6$. The residual sum of squares was $0\cdot191$. The obtained plots of λ' versus the predicted and observed values of N, and of the predicted values

of N versus the residuals are not given here as they were similar to those shown in Figs. 3 and 4.

The mean file access time, R, can be easily obtained by employing Little's relation. We have $R = N/\lambda'$ or using expressions (4.3) and (4.4) we obtain

$$R = 1/(\mu - (\lambda/7)) ,$$

where λ is the rate at which requests are issued, and μ was estimated to be equal to $18\cdot6$.

The quantity μ was defined as the rate at which a request is served at a time no other requests are in service. It was possible to calculate this quantity by simply adding the mean channel time, mean seek time, and mean search and transmission time. Information about each individual mean time was readily available, except for the mean seek time. This was easily estimated by simulation. The quantity μ was calculated to be $18\cdot9$ per second. We note that the estimate $\hat{\mu} = 18\cdot6$ compares well with this exact figure.

5. Conclusion

In this paper a simple nonlinear regression model for predicting the mean file access time of a disc I/O system was presented. The model was not constructed by purely fitting empirical data. Rather, it was a combination of an analytic model and empirical techniques. The analytic model was based on the idea that the execution time of a read or write request depends partially upon other requests in service. This idea is conceptually very simple and it has wider applicability than that considered here (cf. Foster and Perros, 1979). The combination of an analytic approach and empirical techniques yields useful results and it provides an important complement to analytic tools (cf. Svobodova, 1976).

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International conference on data bases

An international conference on data bases will be held on 2-4 July 1980 at the University of Aberdeen, Aberdeen, UK. This is the first international conference of its kind to be held in Britain, and it is organised by the Department of Computing Science of Aberdeen University jointly with the British Computer Society. The conference is expected to cover *all aspects* of data bases, particularly in relation to implementation and concerning: distributed data bases, data dictionary, conceptual schema, end user facilities, performance optimisation, integrity and privacy, restructure and reorganisation.

Invited speakers
Charles Bachman (Honeywell, USA) on the impact of structured data on programming.
Donald Chamberlin (IBM, USA) on the relational approach to data bases.
Eckard Falkenberg (Siemens, W. Germany) on the conceptual approach to data bases.

Conference booking
The conference has only a limited number of places, and demand is likely to exceed supply, so please book early to avoid disappoint-

ment. The conference charge includes registration fee, accommodation in a hall of residence, meals, conference dinner and a copy of the proceedings.

Conference charge (if paid before 1 May)   £127
A surcharge of £20 will be levied as a late fee on all entries after 1 May.
A grant of £30 to defray the conference expenses of any staff or student member of an academic institution (including BCS Students) will be available on request.
Further assistance might be available for research students, please enquire. The organising committee reserves the right to review the charges in February and make changes if necessary.
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