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Book Review

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THE APPLICATION OF OPERATIONS RESEARCH TO COURT DELAY, by John H. Reed. New York, Washington, London, Praeger Publishers, Inc, 1973. 205 pp. $15.00.

The twin problems of excessive courtroom delay and an inordinately large backlog of cases to be tried is recognized as one of the most pressing operational difficulties of the American judicial system. Although the problems have been generally recognized, there has been no agreement as to the methods necessary to solve, or at least to alleviate them. Some of the most common suggestions which have been made for application to an existing court system are:

1. The addition of a courtroom executive to relieve judges of some of their administrative duties. Estimates have been made[1] that such an executive, properly empowered and with a suitable staff, would permit the bench to spend five percent more time actually trying cases.

2. The creation of additional positions on the bench.

3. The reduction in the time of an average jury trial by a considerable amount; say, ten percent. It has been suggested[2] that this might be done by the reduction in jury size from twelve to six, thus reducing selection and deliberation time; by the use of court appointed impartial expert witnesses; and by the increased use of stipulation by opposing counsel.

There are, of course, objections to all of the above suggestions. The first two would entail additional expense over the existing system. A further objection to the courtroom executive is that unless the executive has a reasonable amount of power, he becomes a glorified secretary, with very little additional time being released to the judges for their trial duties. However, the judges would likely have quite reasonable doubts about delegating a portion of their power to a bureaucrat, resulting in a system perhaps even less efficient than the one it supplanted. As to the third suggestion — that of the reduction in jury trial time by ten percent — there is again room for an equally reasonable suspicion that the quality of justice might be degraded, and might proceed with the appearance of undue haste.

The financial, moral, and philosophical implications of the proposed changes surely must be given careful consideration before any

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[1] James Davey, Clerk of the United States District Court for the District of Columbia, is is reported to have made the estimate to Professor Reed on March 26, 1971.

[2] H. ZEISAL, H. KALVEN, JR. & B. BUCHOLZ, DELAY IN THE COURT 69-103, 120-126 (1959).

of them is applied to an existing court. To these problems Professor Reed does not address himself. Rather, he uses mathematical techniques drawn from operations research to assess the effectiveness of the suggestions upon the indicated problems.

Operations research is an evolving discipline whose boundaries are incapable of precise definition; however, one may consider the operations researcher to act as an interface between a maker of decisions and the real world, in the sense that his function is to gather and process data (here rather loosely defined to be the real world), and, by using various operational tools, usually drawn from mathematical and statistical sciences, to present to the decisionmaker the likely results of the courses of action open to him. While the operations researcher and the decisionmaker could be the same person, it has been suggested[3] that the responsibility associated with decision making tends to bias the data gathering and reducing process.

As discussed in Reed's book, the process of operations research may be conveniently subdivided into five major phases:

1. Formulating the problem
2. Constructing a model (often mathematical in nature)
3. Deriving a solution to the model (directly or through simulation)
4. Testing the model and evaluating the solution
5. Implementing and maintaining the solution.

These phases are not totally distinct, and in fact, the fifth phase will usually involve gradual modification of the statement of the problem, the model, and the solution. The usual effect of the fifth phase is the permanent incorporation of the operations researcher into the decision making process. It would not be reasonable to assume that the model and conclusions based on the model would remain valid as external conditions change.

The purpose of Reed's book is to show that such a process is feasible, by presenting in detail the first three steps in the solution of one specific example: the United States District Court for the District of Columbia, as it operated between October 1, 1966 and October 1, 1967.

The initial phase of the author's research consisted of analysing the possible routes that an individual case may take through the court system, and in general analysing the court system, and also the United States Attorney's office. Following this, a data bank was constructed, showing each case's progress through the

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[3] P. MORSE & G. KIMBALL, METHODS OF OPERATIONS RESEARCH 2 (1951).

system. Using graphs constructed from these data, tentative conclusions could be formed. It became apparent to the author that the greatest time lag in a case involving a criminal trial occurred between arraignment and the start of the trial. As the dominant factor in the number of trials starting is the availability of judges to sit for these trials, the above-mentioned three courses of action were selected for testing, and the quantities chosen most worthy of analysis were those dealing specifically with the "loading" of the court system: the average number of jury trials starting per day, the size of the case backlog, and the expected waiting time of cases in the queue.

The model developed by the author may be thus summarized: For each quarter in the chosen year, the number of days, d, upon which t trials started is plotted against t. The line of of regression[4] of d on t is computed, and its slope[5] called m_1, where $_1$ is the number of the quarter. For each quarter also, the average number of trials started per court day, s_1, is computed by dividing the number of trials started by the number of working days in the quarter. When the four values, m_1, are plotted against the corresponding values, s_1, the resulting points lie tolerably close to another line or regression, which we shall call R. To project from this model, Reed requires the following assumption, denoted as (*):

> So long as the general framework in which the court operates remains substantially unchanged, this linear relation between the slope of the day per trial start line and the case load per day will remain valid if minor perturbations are made to the court structure.

As an example of how this assumption may be used to project the results of a course of action, let us consider the effect of the addition of a courtroom executive to the particular judicial system under discussion. By an operating assumption, five percent more time would be released to the bench to try cases. If one assumes that the ratio of cases tried to the court alone to cases tried to the jury remains reasonably constant, the total number of jury trials per

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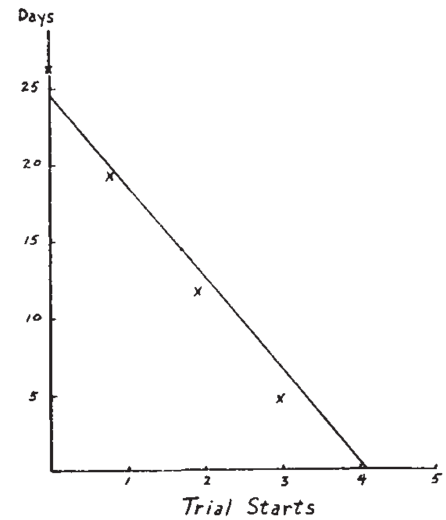
[4] Given a set of points (x_1, y_1) which most likely do not lie on a straight line, there arises the question of what line best describes the data. This question has many answers, depending upon the particular error measurement used. The most common error measurement, obtained by summing $(y_1 - mx_1 + b)^2$ overall points (x_1, y_1), will be minimized when $m = r(sy/sx)$, and $b = (/y) \pm r(sy/sx)(/x)$, where sy and sx are the standard deviation (a measure of the dispersion) of y and x respectively, and /y and /x are the mean (average) value of y and x, and r is the (Pierson) correlation coefficient (measure of association) between y and x. This line is called the line of regression of y on x.

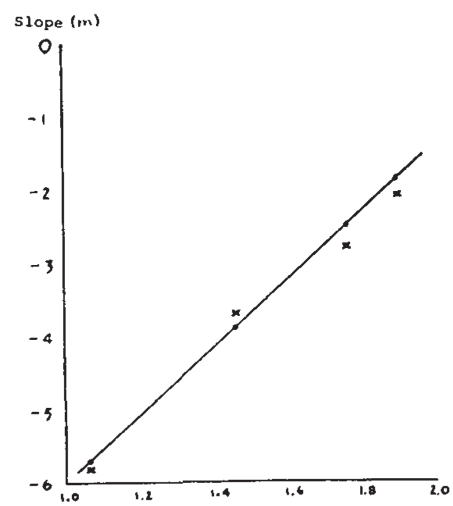
[5] Straight lines usually have equations that may be written in the form $y = mx + b$ (the only lines with equations that may not be put in this form are vertical lines, whose equations that may not be put in this form are vertical lines, whose equations look like $x = c$). the "m" is referred to as the slope of the line; when m is near zero, the line is nearly horizontal. When m is positive, the line rises to the right; when negative it falls to the right. The "b" in the above equation is called the "intercept" or "constant."

quarter (under the addition of the executive), and thus, the average number of jury trials starting per day, may be calculated for each quarter. Let us call these averages $s_1^{(1)}$, where $_1$ is the quarter number, and $^{(1)}$ indicates the first course of action. Using Reed's assumption (*), the slopes of the regression lines ($m_1^{(1)}$) may be computed from the equation of the line R. With this slope, and also the expected (average) value of the number of trial starts, the constants ($b_1^{(1)}$) of the new regression line may also be computed. Thus, in effect, the graph of d against t may be redrawn for each quarter, and from calculations based on these graphs, the new backlog size and the expected waiting time may be computed, and also measures which indicate the reliability of these estimates.

To clarify the method somewhat, consider the following example from Reed's book. The base data for the first quarter are graphed below.



The regression line (which has been plotted) has equation $y = -5.8x + 24$; thus the slope of the line (m_1) is equal to -5.8. The number of trial starts in the first quarter was 67; the average number of starts per day (s_1) is 1.065. In similar manner, these pairs of numbers for the other quarters (s_2, m_2 etc.) may be computed. Plotting these pairs of points on another graph, the line of regression R may be fitted to these points. R has the equation $y = 4.32x - 10.13$. This is the equation which will be used in subsequent prediction (under the assumption (*)).



Returning to the analysis of the effect of the addition of a courtroom executive, the projected average number of jury trials started per day for the first quarter is 1.142, under the assumption that they *would have occurred* if a courtroom executive had been functioning. If, further, this addition did not sufficiently perturb the system so that its "operating point" no longer lies near the line R, the equation of this line may be used to "predict" the new slopes $m_1^{(1)}$, $m_2^{(2)}$, etc., and this information, together with the $s_1^{(1)}$, may be used to compute the new value $b_1^{(1)}$. Thus, for each quarter, the new line of regression (with equation $y = m_1^{(1)}x + b_1^{(1)}$) may be computed, and from this equation and the asumption that the effect of adding the courtroom executive will not significantly effect the progress of cases through the courts in phases other than that from arraignment to jury trial start — for example, the average time from guilty verdict to sentencing would not likely change — the expected waiting time for a case entering the queue and the case backlog change per quarter may be computed. The relative dispersion of these values (given by the standard deviation) and confidence intervals (limits within which the backlog, for example, will fall with 95% likelihood) are also found. The quantities computed for this course of action were: change in backlog, +46 (compared to +51 for the first quarter with the existing court system); expected waiting time for the first case to enter the queue in this quarter, 172 court days (compared to 229).

The confidence interval for the backlog change is 46 $\pm$ 40 (compared to 51 $\pm$ 39), or, in other words, there is a 95% likelihood that the change in backlog will be between 6 and 86, compared to 12 and 90 for the existing court.

Professor Reed stresses that it is the duty of the operations researcher to make available information on the quality of the predictions by providing such measures of unreliability as standard deviations and confidence intervals, to the decisionmaker.

Applying analysis such as the above to the other courses of action and for the remainder of the year, Reed concludes that it is unlikely that any of the courses of action would act to reduce the backlog over the year. If several of these courses of action are applied concurrently, then there is a likelihood that the backlog would be reduced, given that the number of cases input to the court system does not increase.

This book is valuable as a prototype study, and it certainly shows that such an application of operations research to the problem of courtroom delay is feasible. Professor Reed basically has accomplished his stated purpose, yet it is rather regrettable that this study could not be carried along to the place where the operations researchers were actually incorporated into a system, for a case study ranging over a longer time span, in which the projections were actually used, would be extremely valuable.

There are several objections which may be made to the general style of this book, the chief of which are a general opacity in the explanation of the model, an unfamiliarity with the general conventions employed indicating precision of results in scientific usage, and a general tendency to include excessive detail and repetition.

First, a concise description of the derivation of the model, and an actual description of how and why projections were made from the model, was lacking. This information was diffused through three chapters. The clarity of the derivation was not improved by the use of unnecessarily complex formulae. There is a technique ancient in the art of selling mathematical results to non-mathematicians called Numerical Intimidation, the basic premise of which is that if a theory looks impressive enough, and contains sufficient arcane symbols, then it must be an outstanding theory. Chapter 5, "Theoretical Background," is, unfortunately, a reasonable example of this technique. No mathematical analysis was used that was beyond the scope of a standard college course in elementary statistics.

As for the second point, there is an almost universal convention in scientific usage regarding the precision implied by a number. If a value of the variable x is given as 3.94, this is implied to mean that x is no larger than 3.945 and no smaller than 3.935. When Reed states that the projected backlog change is 51.001 (p.93), this implies extreme accuracy where 51, or even 50, would be more in line with convention.

As a final criticism of the book, there seems to be undue repetition of certain statements and formulae. The equation of the line of regression, and of the chi-squared, are repeated at least three times each. Further, there appears to be some material present that would be of interest only to someone actually undertaking a project such as the one reported. The section on construction of the data base, which even details specific IBM card columns into which the data were to be encoded, could probably have been left for private correspondence between a data base implimentor and Professor Reed.

Professor Reed has produced a worthy effort; these few objections indicate annoyances to the mathematically inclined reader. To the non-mathematically inclined, however, the annoyances may present a significant barrier to the understanding of the book and of the use of the powerful tools of operations research.