UNEXPLAINED ABSENTEEISM: A SIMULATION APPROACH

Shlomo Globerson and

Phiroze J. Nagarvala

University of California

ABSTRACT

Unexplained absenteeism among workers in American Industry is significantly increasing and can cause severe dislocation in output. The authors use simulation as a technique to predict unexplained absenteeism. The model is based on real world data including the probability of the first day of absence and the length of such absence as a function of the day of the week. The results include a prediction of the future pattern of unexplained absence, the size of the standby worker pool to ensure a minimum work force with given confidence, and an estimation of the maximum monetary incentive to be offered in order to modify worker absentee behavior.

A SIMULATION MODEL FOR UNEXPLAINED ABSENTEEISM

Unexplained absenteeism, often closely linked to dull or repetitive assembly line operations, is rapidly increasing in American industry. In the last decade alone, the rate of absenteeism in the large automotive assembly plants of Detroit has almost doubled, with at least 5% of the hourly workers missing without explanation during mid-week and over 10% failing to show Mondays and Fridays (1). Assuming illness has no preference for days of the week, this higher absenteeism on Mondays and Fridays can be ascribed to personal preference, and therefore subject to modification by appropriate incentives. Walker and Guest (3) in a study almost two decades ago showed that the worker with the more highly repetitive job was more likely to take the day off without explanation.

The continuing rise in the mean education level of the young worker with his vastly differing expectations and attitudes to working has run head on into industry's quest for increased productivity through expanded automation and miniaturization of the work cycle. Nor is the problem any longer confined to the traditional assembly type jobs but is rapidly apreading to the growing service sector of the economy and in occupations once considered more interesting and rewarding.

Since the shortage of critical workers, whether in an assembly line situation (where the result is most obvious) or in a service industry can cause severe disruptions in output, the prediction of unexplained absenteeism is essential to ensure smooth production and service.

As absent workers must be temporarily replaced by workers from a standby pool, knowledge of the level and oscillations in absenteeism is necessary for management to determine the size of this standby pool. Also, since standby workers can be assumed to be less productive than regular workers, changes in the rate of unexplained absenteeism brought about by incentives, etc., directly affect productivity and profitability.

This paper presents a simulation model to predict absenteeism and the size of the standby worker pool within given confidence limits under different incentive conditions. The model is based on data gathered in the equipment maintenance department of a large company in the San Francisco Bay area.

The model relies upon the following observations developed from field data:

(a) the frequency of the first day of unexplained absence or "sick leave" is predictable

(b) the frequency of the length of such absence is predictable.

Illustration 1 supports the intuitive notion that unexplained absence is most likely to occur on Mondays but denies the equally intuitive notion that such absence would be equally likely on Fridays. Perhaps the thought of almost the entire work week still ahead persuades more workers to "drop out" on Mondays rather than on Fridays, when respite seems just around the corner.

Data on the length of absence, Illustration 2, indicate that the most likely period a worker will remain absent for is one working day. The probability of an employee missing more than one day during each unexplained absence period falls rapidly for two or more days. An absence of eight or more days is considered vacation or predicted absence, and replacement of such workers part of established company policy.

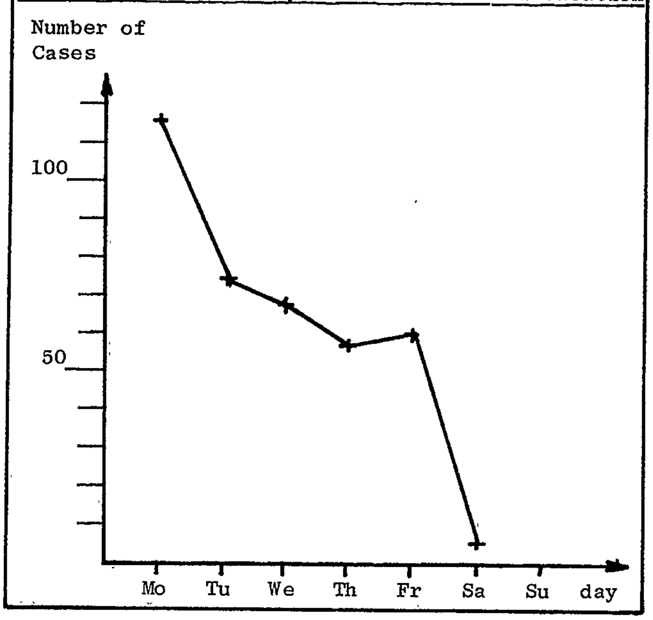
The study proposed here has most commonly been conducted using standard statistical techniques, usually the stationary absorbing Markov chain. This method has been successfully used in a variety of employee replacement models, see for example (2). In this paper a simulation model rather than a Markov chain model will be used to predict absenteeism for the following reasons:

(a) The probability of absence of a worker on day i given his absence on days $j_1, j_2 \ldots j_n \ldots (i > n)$ is not truly stationary. It is conditional on which day of the week i represents. The inclusion of this data in a Markov model greatly increases its complexity and renders an analytic solution extremely difficult.

(b) The results of a Markovian analysis provide the most probable number of workers absent on any given day, or if repeated, in a given series of days. The computational load involved in extending the analysis is not minimal and hence most Markov models cover less than half a dozen time periods--justifiable if each period is a year or at least a month, but insufficient if each period is only a working day. A simulation model overcomes both these difficulties rather well and in addition provides data not only on the daily oscillation of absenteeism but also on how long each of the missing employees has been absent.

ILLUSTRATION 1

Frequency of First Day of Sick Leave and Vacation



The model may briefly be characterized by:

Model input: (a) Weekly probability profile of unexplained absence and (b) conditional probability of absence on any day given an absence on the previous day.

Model output: (a) time series data on the absence/presence of an individual worker and hence (b) a time series on the total number of employees absent, (c) calculation on the size of the standby work force necessary to ensure the minimum number of workers at a given level of confidence, (d) estimation of worker productivity and cost savings resulting from modification of the unexplained absenteeism rate and therefore (e) the maximum incentive costs consistent with an expected change in worker attendance.

ILLUSTRATION 2

Frequency of Length of Absence Due to Sick Leave

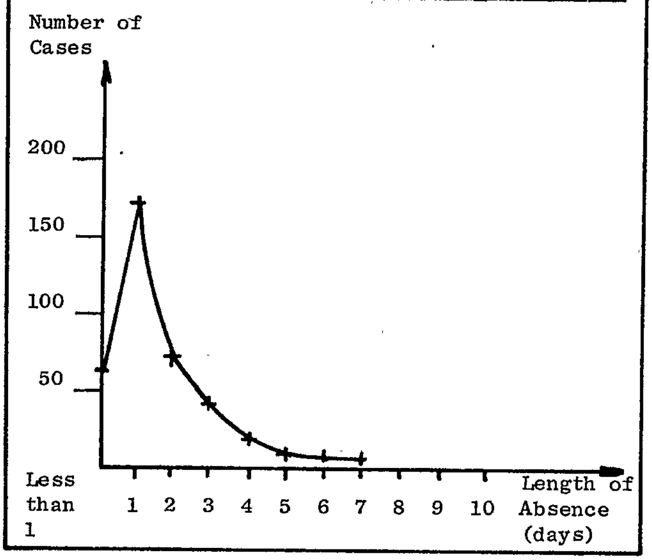


Illustration 3 is the flow chart for the simulation process. The program was written in FORTRAN and computations carried out on a CDC 6400 computer.

Given the two necessary probability profiles, the actual absence/presence of a worker was generated by Monte Carlo simulation using a random number generator over a uniform (0, 1) distribution. A generated random number greater than the probability of absence for that day of the week indicates the worker will remain absent.

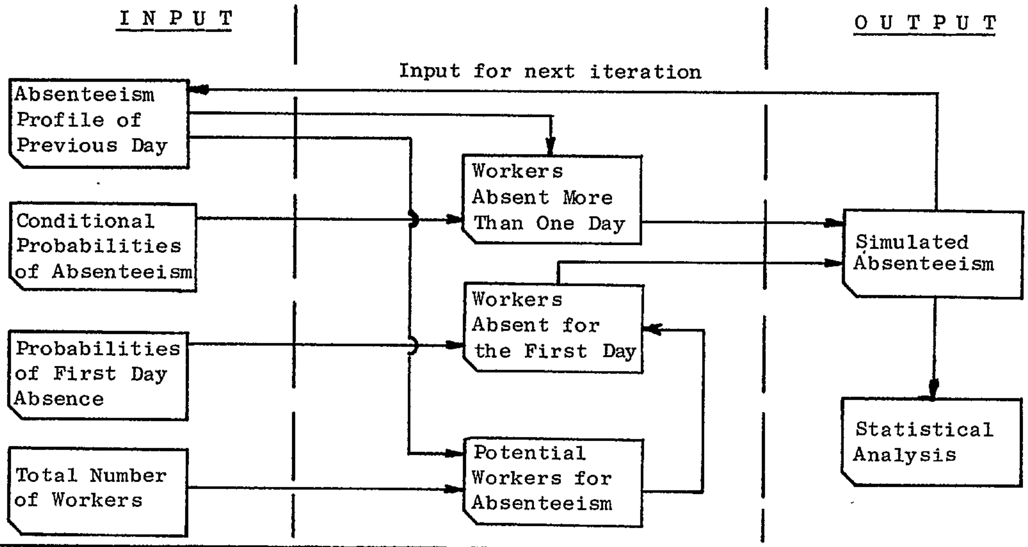
Once a worker has missed a day, the probability of his remaining absent on the following day is similarly calculated by comparing a generated random number with the probabilities implied in Illustration 2. The logic is repeated daily for each worker for the duration of the simulation.

The model was started using an assumed absentee worker profile (i.e., number of workers absent and length of absence of each worker) and allowed to run through 1000 iterations at which point it was assumed all transients, etc., had died out and the model stabilized. The absent worker profile resulting from this run was used as initial conditions for all other runs.

As the model is based on observed functional relationships and field data, validation consisted essentially of matching the observed and generated

ILLUSTRATION 3

Flow Chart of the Model



time series data on the total number of workers absent. The normalized cross-correlation function was plotted for an initial run of 154 points, the maximum number of "real" data points available. This function was smooth, periodic and had peaks in the neighborhood of 0.9 indicating a good temporal match between the two series. The relative displacement or phase shift was of course immaterial.

Having validated the model in this manner, five additional runs, each simulating absentee behavior for 400 days, were made. In each run all parameters were held constant except the probability of unexpected absence on Monday. As remarked earlier, the predominance of unexplained absence on Mondays was assumed to be unnatural in origin, and therefore subject to modification under an appropriate incentive scheme. For the purpose of this model, the probability of unexplained absence was lowered from 0.04 (normal) in equal increments to 0.02 (the minimum probability of unexplained absence is 0.0198 and occurs on Thursdays). For each of these five assumptions, the size of the standby worker pool at the 99% confidence level was calculated. The results are shown in Illustration 4 and plotted in Illustration 5.

ILLUSTRATION 4

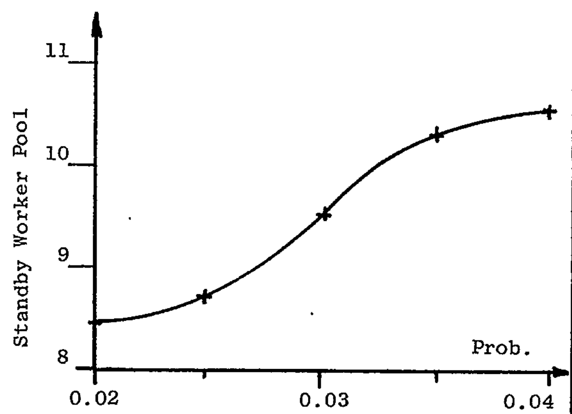
The Relationship between the Probability of Absence on Monday and Size of Standby Worker Pool

	Run 1 (Normal)	Run 2	Run 3	Run 4	Run 5
Probability of Absence on Monday	0.0417	0.035	0.030	0.025	0.020
Size of Standby Worker Pool	10.8	10.5	9.6	8.7	8.5

It is obvious from Illustration 5 that the size of the standby worker pool is strongly influenced by worker behavior on Monday. Reduction of the probability of unexplained absence to less than 0.02, or lowering the probability for the other days of the week was not investigated at this time. Needless to say, if such assumptions can be justified their effect can easily be tested with the present model.

ILLUSTRATION 5

Standby Worker Pool as a Function of the Probability of Absence on Mondays



In addition to the direct costs of maintaining a larger pool of standby workers are the costs associated with decreased productivity when replacement workers replace regular employees. Assuming for the moment

$$y = [N - S]p + [1 - d]pS$$

where y = total production per hour
N = number of workers required
S = number of standby workers being used

p = productivity of regular workers
d = decrease in productivity of standby workers

then y = [N - Sd]p, i.e., the dollar per hour loss loss in total production per standby worker used is pd.

The maximum monetary incentive then is a function of pd, the average number of work hours and the expected reduction in absenteeism.

CONCLUSION

Using field data, a model was developed to predict unexplained absence and the size of the worker standby pool. Assuming the high probability of unexplained absence on Mondays is subject to modification via incentives, the reduction in the size of this pool as a function of absentee behavior is calculated. This maximum reduction in the standby pool also governs the appropriate level of monetary incentives.

BIBLIOGRAPHY

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