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## SOCIETY'S SPECIAL SESSION ON MORTALITY

by James C. Hickman

The study of mortality is a basic concern of actuaries. At the time of the Annual Meeting on November 1, 1967, the Society's Committee on Research, under the chairmanship of E. A. Lew, devoted a special session to Mortality Estimation and Risk Theory Aspects of Mortality. The four papers presented are outlined briefly below.

John Mereu's paper "Measurement of Mortality" was introductory in nature and reviewed the history of actuarial approaches. Much of the earlier literature on this subject was concerned with methods of grouping data into age blocks for use with exposure formulas rather than with the underlying concepts. With modern computers it is now feasible to obtain exposures on a serial basis, and actuaries may concentrate on the problem of finding the best way to allow for partial contributions to exposure in the year of termination. In the past, actuaries have used a particular method of counting exposure and have assumed that the probability that a life aged  $x + k$  ( $k < 1$ ) will die before age  $x + 1$  is proportional to the period remaining.

H. L. Seal has shown that the usual actuarial estimate of the mortality rate has a bias because the exposed to risk depends on the actual mortality of the "existing" or "enders." The correction formula for this bias results in exposing deaths to the earlier of the end of the year of age or the end of their prospective exposure period. Expressions comparable to those developed in discrete form for the correction are also derived for the continuous versions with analogous formulas for the assumptions of uniform distribution of deaths, and of constant force of mortality.

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## IN DEFENCE OF CARTER

by Laurence E. Coward

The actuarial profession, so closely linked with the insurance industry, can hardly be expected to welcome with open arms any proposals (such as those in the Carter Report) for additional taxation on insurance companies and their policyholders. However, the present system of life insurance taxation is so indefensible that a major reorganization appears to be inevitable. In such event, actuaries will have the opportunity and responsibility to help develop the new tax system on a sound and constructive basis.

The answer to H. Edward Harland's question "whether any substantial change in taxation is necessary or desirable?" can only be in the affirmative. It is true that "the life insurance industry has made, and is continuing to make, a substantial contribution to Canada's growth and social well-being." But this is no reason why the industry should not bear its proper share of income tax. Tax incentives for social reasons should be directed at specific objectives and not take the form of tax exemption for a major industry.

At present, mutual life insurance companies are exempt from income tax and stock companies are taxed only on amounts paid to or set aside for the shareholders. The Canadian income tax paid by stock insurance companies is about \$2 million per year. The interest income of the companies is about \$700 million a year, of which roughly one-third will eventually be taxed at a low rate when it comes into the hands of individuals as annuity or pension income. The assets in excess of statutory reserves increase by over \$50 million a year and these are untaxed. Canadian companies pay \$15 million a year in foreign in-

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## TREASURY AIDE VIEWS FUNDING, REINSURANCE OF PRIVATE PENSIONS

by E. F. Boynton

The latest thinking of the Interagency Task Force which is investigating the need for regulation of private pension funds was revealed in a recent speech by William Gibb, Deputy Legislative Counsel for the Treasury Department. The comments were made at a meeting of the American Finance Association as a follow-up to the basic proposals outlined by Assistant Secretary Stanley S. Surrey at the American Pension Conference in May, 1967.

The basic objective of the Task Force proposals is to provide a means to protect vested benefits and, according to Mr. Gibb, this would be accomplished by a two-prong approach: (1) new minimum funding standards, plus (2) participation in a "termination protection fund," heretofore called "reinsurance."

The funding standards now being considered would require that a progressively increasing percentage of the vested liabilities of the plan be funded each year. Specifically, the vesting percentage "target" would increase by 4% per year so that all vested benefits would have to be funded within at least 25 years. The target for existing plans would increase by only 3% per year for the first 5 years as a transitional arrangement, and an unspecified adjustment would be made in the funding target to handle substantive plan amendments.

Assumptions and methods to test the degree of funding of vested liabilities would apparently be prescribed by a Government agency. The contributions to the plan would also have to meet the present normal cost-plus interest minimum now required by the IRS.

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**Review***(Continued from page 7)*

The present article is essentially an exposition of the mathematical methods used and the test of their validity. In particular, it investigates the consequences of using the multivariate normal assumption. Although the authors acknowledge that in fact the underlying distribution is markedly lacking in multivariate normality, the assumption produces reliable and valuable results. The authors conclude: "This method of analysis appears, therefore, to provide a powerful method of analyzing the simultaneous effect of many risk factors on incidence, even in the absence of multivariate normality."

It might be well to remind actuaries and underwriters of the substantive results of the Framingham Study which have previously been observed in articles using less sophisticated mathematics and which are repeated briefly in this paper. The observed risk factors were: age, serum cholesterol, systolic blood pressure, relative weight, hemoglobin, cigarettes per day, and the electrocardiogram (normal or abnormal).

As might be expected, age is the most important single risk factor. Within individual age groupings, the most important factors are number of cigarettes smoked, serum cholesterol, systolic blood pressure and ECG abnormalities. The effect of weight is considerably less significant than the other factors. □

**Mortality Session***(Continued from page 1)*

My own paper, "Statistical Approaches to Mortality Estimation," reported on research done by James Steelman, a graduate student at the University of Iowa, in developing and testing alternative methods of mortality estimation. Maximum likelihood and product limit estimates were developed. Various assumptions about probabilities of death for a period less than one year were used. A computer was used to generate random samples of times until death or withdrawal and to maximize the likelihood functions. Numerical results were produced which enabled certain empirical comparisons to be made. These appear to indicate a slight negative bias in the classical actuarial method of estimating mortality probabilities.

**Mortality Variation**

In a paper "Mortality Variation," John Woody pointed out that the unpublished data collected by the Society's Committee on Mortality is a mine of information. The availability of data on a company-by-company basis would permit study of the actual variation from the expected with that implied by the usual assumptions of the mathematical theory of risk. These deviations would contain trend and company-characteristic components but these could be removed on an overall basis by modifying the Basic Tables to give tables for each experience year and each company. The resulting

deviations would be more nearly random variations on an age-duration basis.

Further improvement would result if data were available on the basis of lives. Given a distribution of claims by size, net stop-loss premiums could be calculated. These often provide a convenient summary of the characteristics of a life insurance portfolio. In conclusion, Mr. Woody pointed out that, since mortality improvement can no longer be taken for granted as in the past, variations from mean values may be more significant to the soundness of the institution of life insurance than the mean values themselves. A large scale application of risk theory to actual data is needed to see how well the usual mathematical models represent reality.

**Random Process**

Paul Kahn's paper "Mortality as a Random Process" reviewed recent non-actuarial research in this field, including the work of Professor Strehler, who appeared at an earlier session of the Annual Meeting. Some of the fundamental notions of stochastic processes were presented, as well as a brief history of the work in studying mortality as a stochastic process. Recent research by biologists and physicists in which aging is viewed as a random process with death as an absorbing barrier was outlined and some actuarial implications of this line of research were indicated. □

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