The Actuary

The Newsletter of the Society of Actuaries

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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 seriatim 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 analagous 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-

(*Continued on page 7*)

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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The Actuary

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EDITORIAL

ONE of the matters discussed in the Klem report which is going to be with us as long as the profession endures is the Education of the Actuary.

Our columns reflect the great interest that our members have shown in the topic. One strain which persists throughout the letters and reported discussions is the possibility of closer association with the academic world. There are several schools in the country with actuarial courses (and we would be glad to hear from them at any time)—but these courses are not, under the present arrangements, a substitute for the Society examinations.

We would like to make the point that we cannot expect to leave the entire training of the actuary in academic hands. The Society must have control of the standards of competence required of its members. Comparison with other professions, law, medicine and accounting, for example, is not easy but in each there are professional qualifications to be met after acquiring an academic degree. This suggests that the proper place of the academic institutions in our syllabus might be for the earlier examinations. We question whether college degrees in, or seminars for, topics now included in our later examinations are a true measure of professional competence.

Not much has been said so far about the content of the examinations except perhaps the to-be-expected lament about memorization. Tests which merely ask for a regurgitation of textbook facts are of little or no value in training a student. There must, however, be a minimum of memory work in all professions for, if the professional is to form judgements, he needs both knowledge and technique.

And on all sides we are asked to consider new techniques to supplant the old. Now the student should not be expected to know all about everything and the E & E Committee hesitates to add to an already extensive syllabus. But what to retain and what to discard? That we will leave to the Committee but we would like to draw the attention of them and of our readers to the comments made by Mr. J. B. Dow in his Presidential Address to the Faculty of Actuaries in 1966:

> "This preoccupation with the practical is something that we must emphasize and cherish. . . . We must be at constant pains to see that we ask our students to study only principles and techniques that they are likely to use. This affects not only the content of our syllabus . . . but also its depth to ensure that no subject is studied too intensively."

—A.C.W.

LETTERS

Straw Votes

Sir:

As a result of the recent close vote on the proposed Constitutional Amendment regarding expression of opinion, several members have suggested that members should be allowed to vote by proxy if they cannot attend the Annual Meeting. I heartedly concur with this.

I would also like to suggest that perhaps *The Actuary* could be used as a means of taking "straw votes" on matters of general interest to members of the Society. This might help to get more actuaries "involved" and would have the added advantage of permitting the members of the Society to give informal expressions of opinion, which are still not otherwise permitted under our rules.

Peter W. Plumley

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Comments on Tooker Views

Sir:

In reading Mr. Tooker's comments on the relegation of the actuary "to the function of a technician" in the December issue of *The Actuary*, I was reminded of some remarks made by a certain Andrew Webster a few years ago. In his Presidential address in 1964, Mr. Webster implied that "the true and chief function" of our educational system should be "to turn out professional men, not high level technicians."

There is a very real danger that, if the actuary restricts himself solely to the function of applying arcane mathematics to insurance problems, he will be definitely contributing to the technician image.

As an indication of the situation we face, I refer to the 1968 LOMA Institute Enrollment Card. On Side A, the candidate is asked to indicate his "Business, Technical or Professional Education." Under Technical Degrees, we find "FSA, FLMI, CLU, etc.," while under Professional Status, the examples are "Lawyer, Physician, etc."

Since only one category is to be indicated, LOMA does not expect "M.D." under Technical Degrees, nor under Professional Status do they expect "Actuary." Perhaps, even within our own industry, the erosion of our status as professionals is already well-advanced.

R. G. Boeckner

Letters

(Continued from page 2)

Sir:

The guest editorial in the December issue of *The Actuary* was described as stimulating, which no doubt means controversial. As an actuary who has spent the last twenty-five years doing operational research I disagree with most of Mr. Tooker's arguments, although I have some sympathy for what I presume to be his objectives. Perhaps this is because I left insurance early enough to retain some professional ideals and have done operational research long enough to learn that it has no guaranteed solutions for an uncertain future.

First, I would question whether the manager and the actuary live in the same business world. In theory, at least, it is part of the actuary's responsibility to protect the customer and this accounts in no small degree for the conservatism and caution which must occasionally exasperate management, although it has more usually operated for their benefit. I think the profession should not relinquish this attitude lightly.

Outside the business world actuaries have shown no lack of enterprise or social conscience, as their vital contribubution to the many social insurance schemes now in operation will testify. It may, however, be less well known that actuaries contributed a great deal to the growth of operational research. In Britain many of the pioneer operational research workers were recruited from the Institute and Faculty of Actuaries; when I moved to military operational research in 1942 there were at least four actuaries in our relatively small group, and they adapted to the new profession if anything more quickly than recruits from the Universities.

Second, I would sincerely hope that the actuary will continue to maintain his professional competence in spite of temptations to "assume the attitudes of a businessman" or threats of being reduced to the rank of a "technician". In these days good technicians are as scarce as good managers. Nothing has been of more value to me than the knowledge and techniques learned as an actuarial student, in particular that the only way to obtain a quantitative guide to the future is to base it on a realistic evaluation of the past and the present.

Third, as I remarked earlier, operational research has no guaranteed solutions. Its practitioners have devised some new techniques, none of which should be beyond the understanding of a competent actuary. It has achieved its greatest successes where the researchers have been given complete freedom to investigate and criticize all aspects of an operation and its ramifications.

If management is now prepared to allow this kind of freedom, operational research might well produce some useful and perhaps revolutionary guidance for future business operations. Given the same freedom it is quite possible that the actuary could do an even better job; certainly it has been my experience that an internal expert starts with a considerable advantage over an external consultant, except perhaps in the willingness of management to accept his conclusions.

Finally I would like to congratulate Mr. Tooker on his attempting to stir up the actuarial profession. I hope the profession will return the compliment.

G. D. Kaye

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Education of the Actuary

Sir:

Upon reading in your January edition the article on education by John C. Angle and the letter on "Education and History" from Jerome M. Stein, I was prompted to review my file covering work of the Committee on Membership Requirements (the Fitzhugh Committee).

One of the task forces of that committee considered a Survey Reading Course "to provide orientation as preparation for subsequent actuarial studies and practical actuarial work and for selection of field of professional employment, and to provide for covering some of the subject matter now included in Fellowship examinations by means of a survey reading course, thereby reducing the area of intensive preparation in such examinations."

The first item listed among the subjects to be covered in that course was "The Actuary — Scope of profession; history; professional standards."

The report suggested that examination on the subject matter of the course would be "advisory only; no minimum requirement for admission to later examinations."

As I recall, the suggestion of a Survey Reading Course was not adopted by the Committee because of the need to limit the scope of reading and preparation for the actuarial examinations. I join Mr. Stein in requesting that the history of the actuarial profession and the insurance industry be a part of the education of an actuary, and I suggest further evaluation of a survey reading course as one means of limiting the scope of some portions of the Fellowship examinations.

J. Eugene Taylor

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Sir:

Mr. Angle's article in the January issue of *The Actuary* contains a fresh, healthy insight on the future composition of the actuarial examinations. I was particularly interested in his linking the five fellowship examinations with the utilization of university facilities. In a previous issue of *The Actuary*, I made similar suggestions for continuing education after an actuary attains Fellowship. Mr. Angle has extended this suggestion to use the university approach for students studying for the Fellowship examinations.

The trend of the actuarial examinations involves a high degree of memorization, motivation, and sacrifice of time in order to be adequately prepared. Given that the student who attains Associateship has the brains to become a Fellow, the determining factor as to whether he attains Fellowship is his ability to "stick it out," as opposed to his ability to achieve professional competence as an actuary. Our current examination structure is more of a trying experience than a stimulating one. It serves to scare away many potential candidates for actuarial exams who observe the ordeal ahead of them.

One significant question left open by Mr. Angle's article is how to utilize the university approach — and yet maintain the same standards which are currently employed in our present examination structure. Certainly we would not want the average difficulty of a college course to substitute for the higher standards of our actuarial examinations.

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Letters

(*Continued from page 3*)

Without commenting on the myriad problems to be solved should Mr. Angle's recommendations be instituted, and assuming his approach would be feasible, I would like to offer the following suggestions:

- For examinations on the Fellowship level, offer a variety of courses which the students can select in various combinations to obtain Fellowship, which will provide a balance of "core knowledge" and special topic, and which will give the student sufficient flexibility to specialize in one area.
- In place of some part of examination syllabus, give the student an option to prepare an original thesis on an actuarial topic in his chosen specialty field.

I believe these suggestions would go a long way toward stimulating the student in approaching actuarial examinations; in developing original thought on a topic in which he is interested; provide more attraction to potential candidates for actuarial examinations; and give the student more latitude to organize his time in preparing for the examinations in conjunction with his job responsibilities.

Arthur B. Kagan

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Sir:

Mr. J. C. Angle's report in your January issue makes an interesting contribution to the continuing discussion on the educational system for our profession. I strongly believe the type man attracted into our profession bears a direct relationship to the educational system we provide. As one looks around at the giants of our profession this speaks well for the education provided in the past, but we have now entered a different era and the giants of tomorrow will surely be very different men from the giants of the past. To quote from John Angle's report we now have "to compete with more challenging fields for intellectually gifted students."

This leads me to endorse the thought which seems to emerge from John Angle's report that we should be more concerned with the thinking processes of an actuary than with his fund of detailed knowledge, and I wonder if our present examinations really achieve this emphasis. Probably there is not too much wrong with our examinations up to the associate level although I would question whether there is not perhaps some overemphasis on mathematical techniques. I cannot help but wonder if this mathematical emphasis is not frightening away some students who could make a valuable contribution to our profession.

Turning to the fellowship examinations, perhaps there is room for a Ph.D. type thesis in the training of an actuary at this level. A number of these relating to life insurance have been prepared by university graduates in their post graduate studies but I cannot help but feel that a much greater contribution could be made to such literature by budding actuaries.

Although John Angle's report makes reference to both the education of future actuaries and continuing education after qualification, has sufficient distinction been made between the two? For example I submit that on-campus seminars are much more appropriate for continuing education than to replace part of our present examination system as is suggested.

Keith J. Harding

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Investment Year Income

Sir:

I read with interest the article in the January issue of *The Actuary* on the methods of allocating investment year income. I agree with the conclusion that when select periods are employed, the two systems are no longer equivalent.

However, I would think that if the select period is sufficiently long — say, fifteen years — as a rule little inequity would result to a typical participant under one method as opposed to the other, particularly if regular periodic deposits are involved. In practice, this inequity is analogous to that resulting between two participants making deposits at different times in a given investment year when investment yields are rising or falling.

In other words, when an ultimate period is used, one is implicitly using an averaging process for the years within the ultimate period, which is done to a lesser extent with respect to the days and months within a given select investment year.

Richard M. Wenne

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The Klem Committee Report

Sir:

The report of Committee on Future Course of The Society was broad in scope and comprehensive in the treatment of each topic covered. Besides those topics it reported upon, it is likely the Committee also considered others which it did not wish to pursue and left for successor committees. The following four suggestions are offered for future consideration:

1*st*—Along with the suggestion for reorganization of the Office of the Society some thought should be given to the location most suited to the widening interests of the membership. An office in Washington, for example, would enable the Society to keep in close touch with legislative developments of actuarial interest, not only in areas of direct concern to insurance and pension work, but also other areas that might require actuarial attention. It would also be easier for government agencies with actuarial problems to make contact with the profession. Moreover, several of the insurance trade associations maintain offices in Washington and close contact with them could be advantageous.

2*nd*—Several letters to *The Actuary* have brought up the issue of the loss of the opportunity to vote by those who cannot attend the Annual Meeting. This is a matter of particular importance in voting on issues where the result may hinge upon a small margin.

3*rd*—The Society might study the organizational pattern of some other professional associations which have found it desirable to create sections on the basis of specialized interest. Such an arrangement permits each section to participate in organizing the program for the Annual Meeting but does not preclude general sessions for all members. This direction has already been taken for Parts 9 and 10 of our examinations and in the Committees on Mortality and Morbidity.

4*th*—The Society might appoint an Archivist.

M. Spiegelman

Private Pensions

(Continued from page 1)

To protect the unfunded vested liability before the funding target reaches 100%, there would be created a termination protection fund which would require mandatory participation by any plan having unfunded vested liabilities. However, it is not clear whether multi-employer, area-wide plans would be required to participate in such fund.

In the event of a shutdown of a business or operation, which would presumably include a single plant closing, the termination protection fund would cover the difference between the total vested liability and the funding target. Thus, if the funding target expressed as a percentage of the vested liabilities is not met by the assets in the fund, the gap between the target and the actual fund would not be covered by the termination protection fund.

This potential loss of benefits, which could arise from fluctuations in market value or failure to make required contributions, is apparently one problem that the Interagency Task Force is finding difficult to resolve. Mr. Gibb indicated that one alternative being considered is to make such a deficit a legal liability of the company with the same priority as, say, unpaid wages. In the event the employer failed to make up any funding deficit within 5 years, future benefit accruals under the plan would be suspended until the deficit was made up.

One area of particular interest to actuaries in this termination protection idea is the determination of appropriate premium rates for this unique type of insurance. The Task Force proposals are somewhat vague, except to state the position that a uniform premium rate expressed as a percentage of unfunded vested liabilities would be used for *all* plans, as the complexity of measuring the risk of termination would be too great to make a variable rate practical. A rate determination for each plan covered would be required at least every three years, based on the fund's assets and vested liabilities at that time.

Mr. Gibb did not discuss vesting, but indicated that the Task Force is still working on detailed proposals for minimum vesting standards. □

CURRENCY DEVALUATION

by J. Ross Gray

Every company doing an active business in a foreign country is concerned with the problem of fluctuation in the value of different currencies — because its policies will be payable in the foreign currency and it may well, perhaps is forced to, invest in assets payable in that currency.

The obvious way to prevent a fluctuation in the company's surplus due to a change in the value of any particular currency is to have assets and liabilities equal in the currency. This exact balance may be prevented, or rendered undesirable, by a number of influences, such as,

(1) a requirement of the foreign government that a portion of the surplus be held in foreign assets,
(2) the availability, or lack of availability, of safe, profitable investments,
(3) the availability of bonds payable in two or more currencies,
(4) company anticipation of some change in the value of the currency,
(5) book value of assets different from their market value.

Position of Canadian Companies

Because of the recent devaluation of Sterling, and because of the number of Canadian companies which do business in countries where the currency is Sterling or related to Sterling, it may be of interest to see the position of the Canadian life insurance companies at December 31, 1965, the last year for which the official reports are available.

The following table gives the number of companies where the book value of assets in the currency are certain multiples of the liabilities. Some arbitrary allocation has been made with respect to optionally payable securities.

Multiple of liabilities	U. S. Dollars	Sterling & Irish £	British West Indies, $ & £	Others related to £	Total Sterling types	Other
Over 5 times	6	5	–	–	1	–
3 — 5 "	2	–	–	–	–	–
2 — 3 "	–	–	–	–	–	–
1.50 to 2.00	3	–	–	–	1	–
1.20 to 1.50	2	1	1	–	1	–
1.10 to 1.20	3	2	–	–	–	–
1.00 to 1.10	5	2	1	–	4	–
.90 to 1.00	1	1	–	–	5	2
.80 to .90	–	–	–	–	1	1
.50 to .80	–	2	5	–	1	1
.20 to .50	1	–	6	4	–	2
Under .20	–	–	1	–	1	–
	23	13	14	4	15	6

Two observations might be made. U. S. assets have been regarded as a good investment and a safe currency. Sterling of Great Britain has been regarded as good cover for liabilities in British West Indies and other Sterling-related currencies.

These few comments do not touch on the problems which can arise from devaluation, such as rising costs and inadequate contribution to head office expenses.

BY THE YEAR 2000

The Office of the Actuary, Social Security Administration, estimates that the expectation of life at birth by the year 2000 may fall between 69.1 years and 71.6 years for males and between 75.3 years and 77.5 years for females. The corresponding figures for 1965 were 66.8 years for males and 73.7 years for females. At age 65, the estimate for males ranges from 13.8 to 14.8 years and from 16.7 to 17.6 years for females. For 1965, the comparable figures are 12.9 years and 16.2 years for males and females respectively.

YALE CONFERENCE FOCUSES ON ADVANCED TECHNIQUES

by Edward A. Lew

The Committee on Research of the Society has been experimenting with various means of furthering graduate education of actuaries in mathematical and statistical techniques applicable to insurance problems. To this end, it co-sponsored an Actuarial Conference at Yale University, Nov. 30-Dec. 2, 1967. The other sponsors were the Yale Department of Statistics and the Committee on Mathematical Theory of Risk of the Casualty Actuarial Society.

This conference aimed at exploring common interests between actuarial science and other related disciplines. The attendance of 60 actuaries among the 80 participants is evidence that the subjects are of current interest to many members of the actuarial profession. The subjects treated were highly technical in nature and the following note is but a brief summary of the topics treated. It does not do justice to the spirited and pithy discussion which followed the presentation of the papers.

Dr. Paul Johansen, President of the Danish Actuarial Society, reviewed recent developments in the theory of risk as a highly sophisticated model for insurance operations. There are increasingly general assumptions which have significantly enlarged the range of application of this theory. He emphasized the advisability of a broader education for the actuary, such as might be fostered by learning a foreign language as well as a computer language.

Savage and Shubik Views

Professor Savage of Yale pointed out that the insurance business was essentially concerned with rational behavior in the face of uncertainty. He referred to the Bayesian approach as part of a theory of preference based on concepts of personal probability and utility, and indicated that many actuarial problems, such as graduation and credibility, could be explored more sensibly within this framework.

Professor Shubik, also of Yale, characterized game theory as a useful approach to strategic decision making. He pointed out that many real life situations are better described as non-zero sum games and suggested the possibility of solutions through negotiation when the players had common interests.

Simulation was defined as a technique for constructing models of complex organizations, and gaming as a procedure for predicting future states by simulating operations with open decision variables. The relationship between game theory and experimental gaming is discussed by Professor Shubik in his paper, "Some Experimental Non-Zero Sum Games with Lack of Information About the Rules" (*Management Science*, January 1962).

Kahn and Hamming

Paul M. Kahn discussed the development of credibility theory from the Bayesian viewpoint. He showed that for certain types of distributions the usual credibility formula can be regarded as providing the best linear approximation to the posterior premium, on the assumption of the Bayesian approach.

Richard W. Hamming of the Bell Telephone Laboratories, author of *Numerical Methods for Scientists and Engineers* (McGraw-Hill, 1960), stressed that the traditional content of numerical analysis has been changed radically by the advent of computers. In making computer calculations we need to be concerned with "round off noise," truncation errors, and related problems. Dr. Hamming covered much ground in his talk, with emphasis on insight into the nature of computer calculations rather than specific methods.

Anscombe and Seal

Professor Francis J. Anscombe, Chairman of the Statistics Department at Yale, pointed out that before computers, statistical theory relied heavily on linear unbiased estimates and linear regression with relatively few variables. With the aid of computers, it is now feasible to study non-linear relationships and many variables. Professor Anscombe described a new programming language—APL—being developed by IBM, which permits ready handling of arrays of numbers. This language will facilitate direct communication between the statistician and the computer, and virtually dispense with programmers.

Hilary Seal sketched an elegant derivation of the basic equations in risk theory, and showed how notions derived from queuing theory are identical with those in collective risk theory as developed by Scandinavian actuaries. He also mentioned possible use of simulation to calculate "ruin" probabilities.

A limited number of copies of the papers will be available at the office of the Society in April.

Another Actuarial Conference on the general subject of simulation will be held at Duke University, Oct. 31-Nov. 2. In due course, members will be informed of the details of this Conference. □

EDUCATION DISCUSSED AT ACTUARIAL CLUB

At its meeting on Jan. 11, the Baltimore Actuaries Club discussed the "Education of the Actuary" in the light of the reported discussion from the Chicago meeting. While the consensus of the Baltimore meeting was that the present educational and examination system produced satisfactory results, there were many critical comments on detailed aspects ranging from syllabus content and examination methods to recruiting.

Most of these comments were personal, reflecting the examination experiences or educational ideas of the speaker. There was general agreement that something should be done about the Canadian content of the syllabus, and Bert A. Winter's suggestion of removing finite differences from the syllabus seemed to meet with approval.

There was some comment about the multiple choice questions, one speaker suggesting that these were hardly applicable to Selection of Risks. Other topics included how far the Society should attempt to use the facilities of the academic world to meet its needs, and how far actuaries should be trained in statistics and statistical methods. □

ACTUARIAL CLUB MEETINGS

March 5, Canadian Institute of Actuaries, Toronto

March 6, Kansas City Actuaries Club, Kansas City, Missouri

March 14, Baltimore Actuaries Club

March 14, Junior Branch of the New York Actuaries Club

TRUTH IN LENDING — COMPUTING INTEREST ON A CREDIT TRANSACTION

by Robert J. Myers

(Reproduced with permission from The New York Statistician, September-October, 1967, vol. 19, no. 1)

In the April 1967 issue of the *New York Statistician*, Dr. M. R. Neifeld cites a problem of determining the true interest rate on a short-term credit transaction. He then states that computations thereof were made by several marketing professors and government economists, with the results ranging from 80% to 130% per annum and not having any computational errors. This is impossible. There can be only one answer for a discrete problem such as was posed. Dr. Neifeld should have consulted an actuary, not a marketing professor or a government economist!

The problem was to find the true annual interest rate involved when an immediate payment of $20 is to be financed by four $5 payments made 4, 18, 32, and 46 days later and a $2 payment made 60 days later.

The way to solve the problem is first to set up the exact equation in terms of the daily interest rate, as in the following Equation of Value:

$$5\left(v^{4} + v^{18} + v^{32} + v^{46}\right) + 2v^{60} = 20 \qquad (1)$$

where $v = (1 + i)^{-1}$ and i is the daily rate of interest.

Next, we use the Method of Equated Time to find a first approximation to "i". The following expression gives the weighted average time (in days):

$$\frac{5(4 + 18 + 32 + 46) + 2\,(60)}{22} = 28.1818 \qquad (2)$$

Using this value, we determine the first approximation to "i" from the equation:

$$22(1 + i)^{-28.1818} = 20 \qquad (3)$$

By the use of logarithms, we find that "i" is .0034 (i.e. .34% per day). Then, by trial and error, through direct computation in Formula (1), we find that the exact true interest rate "i" can be bracketed by "i" equals .003456 and "i" equals .003457 (since the former results in the left side of the equation equalling 20.00008, while the latter produces a value of 19.99953). Therefore, the true daily rate of interest, correct to four decimal places is .3456%

Finally, we may obtain the true annual rate of interest, "j", from the following formula:

$$1 + j = (1.003456)^{365} \qquad (4)$$

Using logarithms, we find that for "i" equal to .3456% "j" equals 2.526, or a rate of 252.6%. If we wish to bracket "j", we find that for "i" equal to .3457%, "j" equals 252.7%. Therefore, the correct precise answer for the true annual rate of interest — to the nearest percent, is 253%.

Carter

(Continued from page 1)

come taxes, but foreign companies pay no Canadian income tax. It seems clear that the life insurance company is not carrying its weight in comparison with other financial institutions.

Premium Tax Cited

The standard reply is that insurers pay a special premium tax which produces rather more than $16 million a year. This, however, is a provincial tax, in the general nature of a sales tax on services, and is no substitute for income tax. I fully agree of course that in order to avoid over-taxation, the premium tax should be taken into account when the basis of income tax on life insurance is formulated.

The critics of the Carter Report take exception to the recommendation that no deduction be allowed for free surplus and contingency reserves in calculating an insurance company's taxable gain from operations, and have suggested that this seriously impairs the solvency of the companies. They apparently overlook the fact that if it were ever necessary to draw on the surplus and contingency reserves, in order to maintain statutory reserves, a tax credit would arise which would be equivalent to repayment of the tax previously imposed. It appears that the solvency of the company would not be affected, except perhaps to the extent of the interest on the income tax paid.

With respect to the taxation of the policyholder, I hold no brief for the particular method recommended by the Royal Commission. In fact, I believe it would be appallingly complicated to tax the income element in each life insurance policy each year on an accrual basis — and that if income tax is imposed on the policyholder it should be payable only when the policy matures. The Commission was certainly conscious of these problems and two alternative methods are set out in an Appendix to the Report. Moreover the Report states:

> "The recommendations we have made in this chapter are set out in general terms. It will be necessary for the tax authorities to work out, in association with the representatives of the life insurers and the Department of Insurance, detailed regulations that would apply."

In brief, the proposals in the Carter Report are considerably more reasonable and realistic than they have been made to appear. If actuaries are to play a constructive part they should not automatically oppose any changes in life insurance taxation but should seriously consider how to apply the Report's principles in a fair and practical manner. □

REVIEW

by Karl M. Davies

J. Truett, J. Cornfield, and W. Kannel, "A Multivariate Analysis of the Risk of Coronary Heart Disease in Framingham," *Journal of Chronic Diseases*, vol. 20, p. 511, July 1967.

Various aspects of the Framingham Study, which has received considerable attention in medical and insurance circles, have been reported in several journals. The purpose of this Study, which is being conducted by the National Heart Institute, is to learn more of the epidemiology of coronary heart disease.

The Study started in 1949 with a group of 2,187 men and 2,669 women, age 30 to 62, who were free of coronary disease at that time. Seven risk factors were measured on the initial examination and the incidence of coronary heart disease in relation to these factors has been observed and analyzed.

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Review

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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 Wooddy 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. Wooddy 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 nonactuarial 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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