

CHANGING PATTERNS IN ACTUARIAL RESEARCH

Edward A. Lew F.S.A.

Perspective on Actuarial Research

During the nineteenth and well into the twentieth century actuaries in Great Britain and North America confined their research efforts largely to life contingencies. As early as 1853, however, William Farr after his election as Honorary Member of the Institute of Actuaries urged that

'The science of which an actuary practices the application...though at present it principally relates to life contingencies, yet must be held to include all contingencies for which calculation of probability can be applied.'

From its beginning actuarial science embraced the solution of financial problems in life insurance and annuities, but actuaries generally accepted the prevailing notions about investment earnings as a given. There was also little perception that actuaries could develop and reason about statistical observations in areas other than life or health contingencies.

The principal focus of research was on the collection and study of death rates and the construction of mortality tables. Actuarial science drew strength from the habit of painstaking observations of actual experience as well as from a keen sense of the need for reliable information. Careful investigation was seen as the instrument for assuring accuracy and validity of the data. Exploration of the uses of mortality tables and later of multiple decrement tables provided actuaries with practical experience in scientific modelling which led to deeper and more general insights. Comparison of death rates in diverse populations with the more trustworthy figures derived from life insurance records called attention to the wide variability in mortality rates and to the phenomenon of selection.

Premiums and reserves for life insurance and annuities were usually calculated on the basis of past experience, taking selection into account but without any explicit provision for possible future changes in death rates. It was not until the 1940's that formal allowances were introduced to cover anticipated future declines in the mortality of annuitants. A more sophisticated approach to projections had to wait on the advent of estimation theory, significance tests and analysis of time series.

The spectacular achievements of modern statistical theory go back to the first quarter of this century and spring from the pioneering work of such innovators as R. A. Fischer, Von Mises, Markov and Kolmogoroff, and later the contributions of de Finetti, Wald and Savage. The new ideas made it necessary for actuaries to rethink empirical attitudes to probability. As early as 1909 Filip Lundberg anticipated some of these notions in formulating a theory of risk.

When the Society of Actuaries formally established a Research Committee in 1964, it directed the committee to explore the implications for actuarial work of risk theory, operations research and the new methods of statistical analysis. Initially this committee addressed itself mostly to applications in traditional areas of actuarial science. However, the founding of ASTIN as a special section of the International Actuarial Association for the study of applications of modern statistical methods of non-life insurance soon spurred research activities in this field in the United States.

Actuaries had always been seriously concerned about the long range impact of investment returns on reserves and surplus. Little actuarial research was nevertheless directed in the United States at the influences affecting investment performance. In England, by way of contrast, actuaries had developed the Financial Times-Actuaries Index for shares and it remains the British equivalent of the Dow Jones.

During and after the great depression of the 1930's, much thought was given by actuaries to the need for increasing reserves and surplus funds not only to cover investment losses but also to provide for higher reserves in event that interest rates continued at the very low levels to which they had dropped. In the post war years the involvement of the actuarial profession in investment performance grew rapidly. When inflation began to accelerate in the later 1960's, many actuaries were drawn into studies of investment returns, especially in connection with the development of annuity and life insurance contracts under which the amount payable was linked to an index intended to adjust benefits to the cost of living.

In recent years sharply increased competition with new forms of investment and greater volatility of interest rates led to the introduction of new kinds of life insurance contracts, exemplified by universal life policies. This called for actuarial studies of the effect of fluctuations in interest rates on cash flow. The broader issues relating to cash flows in financial security systems as affected by a wide range of diverse contingencies soon came to be addressed. The risk of deterioration in the value of assets held for payment of future benefits was recognized as another contingency requiring separate attention.

Restructuring the Society's Research Activities

In October 1988 the Society of Actuaries reorganized the direction and management of its sponsored research activities. This restructuring had been under consideration by the Research Policy Committee for some time. It was formally presented to the Board of Governors by Irwin Vanderhoof, as the Society's Vice President for Research. I will leave it to Irwin to tell you about the rationale of the reorganization which includes provision for funding selected research projects sponsored by the Society.

Under this reorganization recommendations as to research projects and their funding by the Society are made by the Research Policy Committee of which Irwin is chairman. The Policy Committee assumes responsibility for carrying out the Board's decisions. The management of approved projects is delegated either to the Committee on Experience Studies or to the Research Management Committee. Projects that require ongoing collection of data and continuing follow-up are assigned to the Committee on Experience Studies which operates through the Society's Experience Committee system. Projects which do not fall into this category and this includes importantly new and pilot studies are assigned to the Research Management Committee.

This committee is charged with the direction, control and output of the projects under its supervision. It has jurisdiction over a Project Oversight Group, the preparation of specifications for approved projects, the selection of researchers and the monitoring of the progress in on-going projects. The function of the committee is to give guidance and oversight such as will promote superior results in a reasonable time frame. The committee may also be called upon for advice, as for instance where the material for research is incomplete or intractable or when personnel problems arise.

The Research Management Committee has an important advisory role relating to the solicitation of ideas for research, identification of broader problems for investigation and coordination between projects. The Committee has a unique opportunity to identify gaps in the Society's research activities, since it is in position to evaluate the extent of the Society's efforts in a specific area and call attention to broader issues which have not been addressed. In this way, by pointing up the unsolved problems of importance to the profession, the Committee serves to give the Society's research efforts clearer direction.

At this point I must emphasize that I have been speaking of actuarial research in terms of the projects sponsored by the Society which have been delegated to the Research Management Committee. Much important research is conducted by the Society through different channels.

Thus the Society maintains a number of independent research committees, which also operate under the supervision of Irwin Vanderhoof, as the Society's Vice President for Research.

There is first the original committee on Research, now designated as the Committee for Research in Theory and Applications, of which I was chairman for a number of years. Then we have the Committee on Human Immunodeficiency Virus (HIV) Research, the Task Force on Long Term Care, and Committees on Government Statistics and on Relations with Statistical Organizations. The projections currently being developed by the Committee on HIV Research demonstrate how valuable modern statistical theory can be. The Committees on Government Statistics and Relations with Statistical Organizations may be regarded as connections to extensive data bases of great importance to actuaries. The potentialities of the Actuarial Education and Research Fund, which functions on behalf of five actuarial organizations, are only just being tapped on projects of major importance, as exemplified by the publication of a monograph on 'Fundamental Concepts of Actuarial Science' by C. L. Trowbridge.

We also need to remind ourselves of the formidable amount of research done by individual actuaries. Judging by the papers published in the Transactions over the past five years, about 20% of these papers dealt with simple life contingencies, about 15% with theoretical issues and about 10% each with investment problems, health care issues and pensions. While the number of papers on investment problems has increased somewhat over the years, it still remains a minor subject in terms of papers in the Transactions.

Major Research Projects Completed in the 1980's

Before proceeding to discuss the research projects which the Research Management Committee has on its agenda, I would like to tell you about two major studies recently completed under the sponsorship of the Society. These are the 1983 Impairment Study and a Volume on Medical Risks which has taken seven years to complete and which will hopefully be published by year-end. These two studies exemplify the kind of projects on which the reputation of actuaries for research has rested in the past.

Both of these projects were joint ventures with the Association of Life Insurance Medical Directors of America and were in the classic form of medico-actuarial investigations started at the beginning of the century. Both studies rank high among the scientific contributions made by actuaries and medical directors of life insurance companies working together. Insofar as actuarial research is concerned, the two studies developed several refinements in the techniques of follow-up and analysis of mortality data.

The 1983 Medical Impairment Study was the seventh in a series of comprehensive mortality investigations among insured lives. These investigations have not only provided a scientific foundation for appraising medical risks in numerical terms but have also become an important data base for medicine and public health, notably for the less serious conditions such as overweight and hypertension. The current standards for overweight and hypertension used by physicians derive from the findings of these insurance studies.

The studies have the great merit of relating to well defined populations which have been traced for long periods of time without any meaningful loss to follow-up. The large numbers covered have made it possible to select 'clean' cases for inclusion in the investigation so that the conclusions apply to specific impairments free of complications. Clinical studies based on small numbers

that resort to regression methods are sometimes suspect because the factors in biological phenomena are not simply connected.

The detailed analyses in the 1983 Medical Impairment Study were carried out by severity of impairment, age, sex, time elapsed, causes of death and calendar year periods. The observed changes in relative mortality with the passage of time were frequently quite pronounced, indicating that incidence of the extra mortality must be taken into account in estimating life expectancies.

The new 1500 page volume on Medical Risks represents an unprecedented attempt to translate the findings of a variety of medical, public health and special studies into a uniform life table format. More than 250 medical and public health studies were drawn on, alongside of some 100 studies from the experience among insured lives. The volume contains unique information on the ranges of mortality associated with various impairments in different circumstances, such as in hospital patients, patients of individual physicians, in groups of persons covered by special surveys, among employees of large corporations and among insured lives.

In order to facilitate meaningful comparisons, the actual mortality recorded in each study was, whenever feasible, related to contemporaneous death rates among gainfully employed persons or insured lives. Comparisons with population death rates can be very misleading in studies of occupational hazards or lesser physical impairments because they understate the extra mortality involved.

The new volume contains more detailed information on long term prognosis than can be found in a text book on medicine. The figures show the ranges of mortality for a wide variety of medical impairments, including hazards associated with different life styles, such as heavy smoking, excessive drinking

and undisciplined behaviour. The numbers presented can be used to assess health status, in the analysis of health practices and in health resource planning. They are also needed to estimate costs of impaired health and for such actuarial determinations as structured settlements.

These two projects represent a high level of achievement in producing comprehensive data bases from carefully evaluated material. It is likely that similar information compiled in the future will be incorporated in national medical research banks.

These valuable compilations about mortality risks should be regarded as a challenge to produce analogous data bases for other contingencies of interest to the actuarial profession.

Research Projects Currently Under Way

The Research Management Committee currently has under its supervision eight projects which have been approved by the Board of Governors and delegated to it for direction and control.

These projects can be categorized as follows:

1. Three projects are for the compilation of data bases:- one in the area of health care, one relating to bond investments and the third on US economic statistics for pension actuaries.
2. Two projects call for studies in the investment field. One is directed at the relationship between quality of investment and risk of default in different types of life insurance company investment. The other is addressed to cash flow problems under interest sensitive products.
3. Two projects call for studies in the field of health care. One is aimed at the collection of information and investigation of the actuarial aspects of continuing care retirement communities. The other is intended to examine the effects of adverse selection in health insurance.

An eighth project was added as a joint venture with medical directors of life insurance companies to validate selected medical tests which have been widely used in underwriting. This project may prove to have great value in diagnostic medicine.

There is general agreement that it would be highly desirable to develop more adequate data bases in many areas of actuarial research. In most such areas knowledge has been accumulating so rapidly that it has been necessary to adopt selective controls on the information to be included. On the other hand, in areas characterized by contrary findings care must be taken to include appropriate samples of different results. The health insurance field provides many illustrations of such problems. In the proposed health data base it was decided to proceed with a feasibility study to determine how the information should be organized.

Several projects have been advanced as a beginning for more intensive research into investment performance. Such original research is believed to be indispensable if the actuarial profession is to play a more significant role in the area of financial services.

Two projects in this area involve compilation of data bases. The project for a data base on bond investment has been referred for cost estimates to a group headed by Mark Doherty. A compilation of US economic statistics for pension actuaries has been started in the pattern of a report brought in by the Canadian Institute of Actuaries.

Another project aims to explore in some detail the relationship between quality of investments and the default risk. The initial proposal called for much of this research to be carried on in an academic setting. This has raised the issue whether a study carried out by non-actuaries at the request of the Society would be seen as original actuarial research.

Still another project calls for analysis of cash flows under interest sensitive products. The pilot study will concentrate on cash flows under Single Premium Deferred Annuities. It will be followed by a broader investigation of more difficult problems such as those arising on universal life contracts.

The project to study the actuarial aspects of continuing care retirement communities involves the relatively uncharted area of complete care for the elderly. It may be regarded as a commitment by the actuarial profession to assist in the solution of a major national problem. At this stage the research calls for a review of the limited information available, identification of the main components of the financial operations, selection of models to represent the financial experience and validation of the models through follow-up of the experience. The Society has solicited proposals from the membership to undertake this very important piece of research.

The project to develop ranges of normal values for the more common medical tests from the experience among insured lives is one that can with a few minor modifications rely on well established record systems for gathering data and analyzing the experience. The benefits of this project for the life insurance business are overshadowed by its potential value for diagnostic medicine in providing more meaningful scientific criteria of normality on medical tests.

Some Projects Under Consideration

In recent years the Society of Actuaries has put stress on its basic responsibility to enhance professional expertise through research. This is a call for actuaries to engage in original research ⁱⁿ areas that bear directly on the future of the profession. One of these areas lies in the knowledge and understanding needed for various kinds of financial services. Another is the crucial problem of making better projections, notably in the field of health care. A third area involves participation in the development of computer science where it relates to actuarial calculations.

To demonstrate expertise in the area of financial services actuaries should engage in original research on evaluating investment performance. English actuaries made their mark in the financial world by developing the Financial Times-Actuaries Index for shares and more recently have come to dominate research in the English bond market. Inasmuch as American actuaries have access to the records on high grade bonds in the portfolios of American life insurance companies and pension funds, which comprise a highly satisfactory data base, it would be appropriate for them to develop an index for such securities from a continuing investigation of the experience. I believe that this research should be carried on by actuaries and not delegated to others, if it is to be credited to the actuarial profession.

The risk of default on bonds has been studied extensively. At the spring meeting of the Society in May 1987, Irwin Vanderhoof presented an excellent summary of the relevant findings in major studies.

The risk of deterioration in the value of bond portfolios can be measured by reference to changes in bond ratings. A continuing experience study of high grade bonds, such as those held in the portfolios of life insurance companies and pension funds, could provide needed information on changes in the value of such bonds in relation to changes in bond ratings, as well as in relation to rates of default. Inasmuch as bond ratings have been used to determine whether such securities may be valued on an amortized basis, an experience study along these lines would be helpful to the NAIC.

The object of such a study would be to detect broad classes of 'sick' bonds in early stages of morbidity, so that morbidity tables could be used for analyzing the experience. It would, of course, be illuminating to associate changes in bond ratings with specific events or trends, such as leveraged buyouts or other pronounced increases in corporate indebtedness. Tracing such associations requires bringing in much outside information, the availability of which needs to be ascertained. Work on this phase of the project has already been initiated.

The fundamental problem in much actuarial work is that of developing exercises in foresight with respect to various contingencies by exploring the ranges of possibility likely to open up in the years to come. The late Frank Redington made this point eloquently as follows:

'The actuary cannot break laws and see through the infinite clouds of probabilities that nature interposes between us and what is to come. What he can do and does is to sense the wide ranging possibilities that the future may have in store and make them a living part of the present where decisions are made.'

We are living in a time of great foreshortening in the range of predictability and may have to settle for anticipations limited to a short range. We need, nevertheless, to try and detect pending discontinuities in long established patterns, keep an eye on possible abrupt changes and endeavor to discern interactions between technological, social and political developments. The dramatic changes in the area of health care delivery arising from technological and social breakthroughs illustrate the difficulties confronting us.

Dennis Gabor described this dilemma and proposed a dynamic tactic as follows:

'Rational thinking, even assisted by any conceivable electronic computers, cannot predict the future. All it can do is to map out the probability space as it appears at present, and which will be different tomorrow when one of the infinity of possible states will have materialized. Technological and social inventions broaden this probability space all the time; it is now incomparably larger than it was before the Industrial Revolution, for good or for evil. The future cannot be predicted, but futures can be invented.'

Exploratory simulation appears to be the most promising tool for visualizing the ranges of possibility. We need also to cultivate the art of reasoned conjecture to replace casual intuitions based on past experience with a careful analysis of the dangers and opportunities which the future may present. The hope-

ful premise here is that we might be able to affect the future by helping certain events to happen or prevent others from occurring.

Charting possible outcomes may enable us to visualize potentially serious emergencies as well as unusually favorable developments and so be in better position to deal with adverse situations or take advantage of special opportunities. This is the great virtue of contingency planning.

Another line of attack, sometimes referred to as 'future analysis' depends on defining objectives more precisely, identifying ranges of likely futures and their probabilities, anticipating possible reactions and evaluating alternatives to select an optimum course.

The field of health care presents a special challenge for better projections. There are numerous contingencies to be considered as well as interactions between them, notably between technological, social and financial developments. More intensive study needs to be given to ongoing experience with such changes.

One of the instruments for more sophisticated projections lies in computers that can handle complex modelling. In the early days of computers a few actuaries, among them Phillips, Berkeley, Davis, Finelli and Halmstad, made important contributions to applications in actuarial work. The Society of Actuaries has in effect had a Committee on Computer Science ^{for over 40 years} but I was recently told that the current committee which functions in the area of continuing Education may be discontinued. I believe we should have an actuarial committee engaged in computer science research to keep the profession abreast of developments in this field. Actuaries should be in position to respond quickly to new computer systems that could speed up and enhance calculations and modelling. We must not underestimate the great potentialities of systems that provide for parallel processing, programs capable of dealing with second and third order interactions and systems that have some ability for learning from experience.

To sum up, the Society of Actuaries has recently made major commitments to research by increasing staff, providing some funding for sponsored projects and restructuring its management of sponsored research. These steps facilitate more research activity not only by the many committees formally appointed for this purpose but also by other Society committees and by individual actuaries. Encouragement will be given to every worthy project no matter the area, but greater oversight of research activities has made it easier to identify the important gaps in the overall research program. In my judgment, we ought to address ourselves more intensively to original research, particularly in the fields of financial services and health care, coordinate the numerous projects under way and give more attention to the crucial problem of better projections.