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## TO BE CONTINUED

*Editor's Note: This article is submitted by the Committee on Research. Comments will be welcomed by the Committee and by the Editor.*

### Actuarial Research at North American Universities

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### 1. INTRODUCTION

When the Society of Actuaries Committee on Research was asked last summer to investigate and write a short report for *The Actuary* on the current situation in actuarial research at the Universities, a short one-page questionnaire was developed and circulated to a limited sample of North American Universities with actuarial programs.

This questionnaire asked whether the University addressed was conducting any research in actuarial science, who was involved in such research, in what direction further research was to be encouraged and, finally, further comments and suggestions were invited.

The response was unexpectedly high—over 75% of the questionnaires were answered, often quite elaborately.

Table 1 below lists the responding Universities, alphabetically ordered by a two letter code (in the remainder of this article the responses are referred to by means of this code.) For the benefit of any readers who might wish to obtain more detailed information, for each university the name of the respondent is also shown.

Table 1   Responses to Questionnaire

| | | |
|---|---|---|
| BC | University of British Columbia | Phelim Boyle |
| BS | Ball State University | John Beekman |
| DU | Drake University | Newton Bowers |
| JM | | John Mereu |
| MA | University of Michigan, Ann Arbor | Cecil Nesbitt |
| MR | Mathematical Research Centre, Madison | Tom Greville |
| NE | North Eastern University | Geoffrey Crofts |
| NL | University of Nebraska, Lincoln | Cecil Bykerk |
| PS | Pennsylvania State University | Arnold Shapiro |
| UI | University of Iowa | Stuart Klugman |
| UL | Université Laval | Jacques Faille |
| UM | University of Manitoba | Amir Bukhari |
| UW | University of Waterloo | Frank Reynolds |
| WM | University of Wisconsin, Madison | Jim Hickman |

In Section 2 an overview of subjects of current research is given, each subject being followed by the code for the school (or schools) engaged in that particular area.

Judging from the many suggestions and strong representations for financial and other support expressed in the responses received, one must conclude that this is an area of great concern for almost all responding academics. Section 3 reports on proposals for encouraging the appropriate bodies to provide such assistance.

### 2. SUBJECTS OF ACTUARIAL RESEARCH

There is a large number of researchers working on risk theory topics and a smaller but still significant number working on graduation, analysis of time series, and similar topics. Really suprising was the large number doing research in the pension area. This would appear to indicate the importance of research in a very active and practical field; one which is rapidly changing and in which, to the detriment of all concerned, non-actuarial views may prevail unless our profession steps in.

An overview of the responses follows:

(i) *Pension Topics*

*Design:*
General (UW)
Indexing, inflation (UM)

*Legislation:*
Impact of current legislation on costs (UM)

*Funding and Valuation:*
General (UW)
Portability of Pensions (UL)
Dynamic and Stochastic models (MA,WM)
Valuation of Pension Plan Liabilities (UL)

*Social Security:*
Mathematical models (MA)
Social Security, wealth and private savings in Canada (BC)

(ii) *Risk Theory and Related Topics*
General (MA, UI, UW)
Practical applications (BS)
The problem of claim fluctuation reserves (UM)
Stop-loss reinsurance pools (MA)
Gamma-distributions and risk theory (MA)
Catastrophe insurance (WM)
Credibility theory (WM)
Risk classification (UW)
Economic Theory of Risk (UL)

(iii) *Graduation*
Theory of graduation (MA)
Bayesian methods (WM)
A linear programming approach (WM)
Adjusted Moving Averages: The $L_1$ norm (WM)
Extension to end-values (MR)
Smoothest A.M.A. formulas (MR)
Graduation Problems in Mathematical Demography (UL)

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(iv) *Mortality*

Bayesian methods and mortality projections (WM)

Cancer mortality models (BS)

Cystic fibrosis—continuing study (MA)

(v) *Probability and Statistics*

Stochastic processes with applications to finance (BC)

Applications of novel statistical methods to problems of graduation, mortality estimation, and credibility (UI)

Time series analysis (BS)

(vi) *Finance, Investing*

Policy loan rate determination (NL)

A riskless strategy for equity-linked contracts (BC)

(vii) *Industry Regulation, Legislation*

Regulations of insurer solidity through capital and surplus requirements for the underwriting of non-life insurers (PS):

(a) new enterprises

(b) going concern analysis

(viii) *Miscellaneous Topics*

Accounting:

Extension of general accounting theory to life insurance and pension plans (DU)

Computers:

Development of in-line system for computation of functions arising in insurance and pension work (UM)

Application of micro computers to various insurer operations (UM)

Rate Making (MA)

Disability Income (UW)

Cost comparisons (WM, UW)

Cost analysis (UW)

Taxation (UW)

Most of the above subjects were mentioned as areas in which more research should be undertaken, but other directions for further research were also advocated:

• Pension funding appeared to be in the forefront of subjects requiring further research: suggestions were received for work in all of the pension areas, particularly funding (UM), for dynamic and stochastic approaches to pension funding (BC, MA, PS), and social security (MA), and for work on pension funding under conditions of wage inflation, benefit adjustment, and fluctuating work forces (WM).

• Strong support for further development in risk theory, particularly its practical applications (NE), and credibility theory (BS) was noted, as well as various subjects in statistics, e.g. time series analysis (BS).

• Application of statistical methods (mathematical statistics) to insurance and pensions (UL).

• The most specific proposal for further investigation was the one for development of statistical criteria for values of the constant "k" arising in graduation by means of a Whittaker-Henderson difference equation (MR).

• Developments in mortality theories (NE) and use of Bayesian methods (WM) and demographic projection matrices (MA) for mortality projections were also recommended for investigation.

• In the investment and finance area a suggestion was made for the application of advances in the theory of financial economics to actuarial problems (BC).

A number of miscellaneous subjects in which further research is to be encouraged were brought forward. These included:

• review of relevant plans of disability income insurance in different jurisdictions (UW).

• disability income: discrimination against women (UW).

• cost comparisons between dissimilar policies (UM).

• quality of surplus of risk funds (NE).

• determination of amounts of surplus required to adequately support the group business (JM).

• determining an appropriate level of contingency charges (JM).

• corporate planning (NE).

• areas related to current or pending legislation or to industry needs (PS).

• investigation of new opportunities opened up by recent rapid advances in electronics and computer technology (UM).

• liability insurance for nuclear power plants (WM).

• catastrophe reinsurance pools (WM).

There appears to be no shortage of topics that need working on and, for many of these, non-academic actuaries could see a very practical value in research being undertaken at the universities.

## 3. ENCOURAGEMENT OF AND FINANCIAL ASSISTANCE FOR ACTUARIAL RESEARCH

From the responses received it appeared that most suggestions for improvement in this area were addressed to what can be done by the academic community itself, by the professional organizations (Society of Actuaries, Canadian Institute of Actuaries) and by the insurance industry. We shall consider these three categories in the order named.

Many researchers felt that they would benefit from more contact and exchange of ideas with their fellows; means for this already existed, such as in workshops at Society and Institute meetings, the Research Conferences organized by the Society's Committee on Research and publication in ARCH, but there was room for improvement. Conversely, research at the universities was considered to be impeded by the attitude of some professional journals: ". . . the requirement that a paper be of interest to a substantial number of actuaries almost guarantees insularity" (WM).

## To Be Continued

Interdisciplinary work with economists, demographers, financial analysts, and lawyers should be encouraged (UL).

Some suggested that the Society should commission re-write work on the more mathematical and theoretical study notes (DU) and on some of the textbooks now on the syllabus, and should encourage the creation of new texts to reflect changes in the educational requirements of actuaries (DU, UM).

Others felt that the actuarial bodies should consider giving direct financial assistance to support research (WM), either by awarding prizes, e.g. an annual prize for the best paper(s) produced by their members (BC), or by, for instance, supporting the full time research of some professors each summer (BS, DU, UW). Liaison between the Society's Director of Education and academics could result in "mini-sabbaticals" (DU); ". . . the basic problem . . . is identification of research areas and coordination with those who will use the results" (UI).

It was noted that the CIA Mortality and Morbidity studies could, at virtually no additional cost, be carried by the universities, thus increasing the professors' internal prestige as a welcome byproduct (UW).

It was also proposed that the Society should keep a well-publicized and periodically updated list of available theoreticians so that, when a company needed a solution to a particular problem, it could consult this list and finance an academic to do the research rather than, as is so often done, setting up a committee to do this. As for costs, "for the industry this (would be) little more than the cost of a single committee meeting" (UW). Cooperation between university researchers and the industry should be strengthened (UL).

With respect to industry attitudes, most responses could be considered to fall in two categories. First, there was some strong feeling that pressure on young actuaries to pass exams prevented them from undertaking research projects and created a tendency to see instruction aimed at exam passing as the only function of university actuarial programs (NE), WM). Direct recognition of the Master's degree in salary determination would help (UI).

Secondly, strong representations were made urging the insurance industry to "contract out" research to the universities: ". . . the university . . . is an environment for the pursuit of research which the industry needs accomplished but (which) . . . is either not being done or is being done by individual companies instead of on an industry-wide basis. The funding of such research could come from the industry, thus benefitting . . . the universities as well as the industry" (NL).

One response (UW) listed a number of projects for which assistance had been requested from both government and industry, but which had all been refused (one was refused by an industry committee on the grounds that "it was felt that actuaries were not qualified to do research into life insurance of a broad nature"!); in addition, great difficulties were encountered in obtaining information from industry sources.

More understanding from the industry would be a great help—". . . there appears to be little recognition of the fact that an industry brief carries less weight with legislators and regulators than a brief by independent University professors" (UW).

One respondent mentioned that a project for simulation of a life company operation was "farmed out" to an outside agency before it had been offered to one of the universities' actuarial departments (PS).

The comments regarding suggestions to the academic community and professional organizations could have been more or less expected, although this does not make them any less important; the suggestions to the industry however are most revealing and should be given very serious consideration by companies and consulting firms. With some very minor changes in the way they do things there could be a major impetus to research in the universities that could benefit the whole profession (and the industry!).

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## Mortality Mensuration

done. Professor Batten utilizes a "generalized calendar age" tabulating rule which prepares the reader for dealing later with fiscal age tabulations, a task which has traditionally been a difficult one.

Another useful feature of the text is a significant emphasis placed on the algebraic proof of the equivalence of counterpart formulas. In the older text, Mr. Gershenson apparently assumes that such equivalence is intuitively seen, and that an algebraic demonstration thereof is not necessary. Although Gershenson's assumption is quite reasonable, an algebraic proof, if not over-emphasized at the expense of general reasoning, can also be instructive.

Candor requires, however, that several criticisms of the text be mentioned.

There is undue emphasis on mathematical foundations and analysis of various mortality assumptions in Chapter 1. This material fundamentally belongs to the subject of life contingencies, and is adequately treated by Jordan. A brief review of this material would have been appropriate by Professor Batten, but the emphasis which he has placed on it may cause readers to overestimate the importance of solving algebraic manipulations at the expense of the basic purpose of the text, an understanding of the theory and practice of experience investigations and table construction.

The set of individual record exposure formulas in upper case notation, referred to by Gershenson as "against the traffic" formulas, is developed totally algebraically by Batten, with no supportive general reasoning or intuitive explanation. The same can be said of his development of continuous formulas from their associated single interval forms. Pedagogic considerations would seem to require that a text point out the logic and rationale of formulas, in addition to their algebraic correctness.

In Chapter 5, Batten develops valuation schedule formulas based upon the uniform distribution of deaths assumption. Such formulas are certainly viable alternatives to the traditional Balducci-based set; in fact, one of the UDD-based is probably the most widely used of all