JEF L. TEUGELS AND HELEN RAMSEY

THE ENCYCLOPEDIA OF ACTUARIAL SCIENCE[1]

We give a short historical survey on why and how the Encyclopedia has emerged. We consider both the editorial and the managerial side of the project. We indicate some of the special features of the work.

1. HISTORICAL DEVELOPMENT

We give a short overview of what happened with the encyclopedia from its conception in August 2000 until its appearance in July 2004.

1.1 CONCEPTION

The original idea to compile an Encyclopedia of Actuarial Science (EoAS) emerged from discussions between the authors of this paper on the occasion of the Joint ASA-IMS meeting in Indianapolis, August 2000. As one of the world leaders in statistics publishing, Wiley exhibited at this meeting. Helen Ramsey (HR) was a member of the Wiley team. HR's first suggestion was to publish a series of survey-type books covering the fields of Operations Research and Econom(etr)ics. After some discussion it became apparent that actuarial science was an area in which there might be a demand for a reference work. Indeed, the subject had a long tradition from the academic side as well as from practice. Moreover, possible links with economics and with the financial world opened up market segments where the product could be introduced.

Jef Teugels (JT) then accepted to think about an Encyclopedia of Actuarial Science but under the proviso that he could select a co-editor from practice. In the past, JT had collaborated with Björn Sundt (BS) from *Vital Forskring ASA*, Norway on a couple of scientific papers [3], [4] and [5] and hence, he was a natural candidate coming from practice but who had also served as an academic at the University in Bergen, Norway.

Wiley first undertook a *market study*. A questionnaire was sent to a variety of potentially interested people from academia, insurance and reinsurance companies and banks. The feedback from this investigation was

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[1]Invited lecture and paper.

2000 *Mathematics Subject Classification.* Primary 60.00, 62.00, 62P05, 91.00, 91B30.

Key words and phrases. Life insurance, nonlife insurance, pensions, premium calculations, reinsurance, reserving, risk theory, finance, economics, probability theory, statistics.

overwhelmingly positive. Some hundred individuals replied, offering comments, suggestions and often cooperation. As a result, Wiley's market research lead to the decision that the project was given a go ahead. JT and BS agreed to edit the volumes and publication was scheduled for June 2004.

1.2. Section Editors

The first main assignment for the editors was the compilation of a draft of an alphabetical *master list*. Articles either related immediately to actuarial science or they could be considered as necessary, supportive information. Moreover a large number of potential topics that one could consider belonged to the grey zone in between. There clearly was a need for more structure. Following the examples of other encyclopedias published by Wiley like [1] and [2] the master list was subdivided over twelve sections with a further 13-th for extra topics. The idea then was to rearrange the alphabetical list of more than 600 articles into as many sublists as there were sections planned. For each of these sections the editors would then search for *section editors* (SE).

The quest for section editors was started in the middle of 2001 and a list of potential section editors was made up. During the market research, the replies to the questionnaire already suggested a couple of obvious appointments. For the others the main editors tried to strike a balance between people from academia and people from financial institutions like banks and insurance companies. Attempts were also made to reach a wide geographical spread of the entire editorial board.

The editors informed candidates how each of the section lists was containing a number of more or less specific articles that needed to be covered in that section. Evidently, some of the sections would overlap and occasionally articles needed to be replaced or shifted to other sections. The ultimate decision on what to include and in what format would then be taken after negotiations with all of the section editors. All by all, the section editors were asked to look for redundancy and completeness of the lists and their views were used in designing the final list of sections and articles. For two sections, the approached candidate accepted the task but requested the help of a self-chosen co-editor.

By the Fall of 2001 all sections had their own editor. On 25 October 2001 the contracts between Wiley and the main editors were signed on the premises of Vital Forskring ASA in Oslo, Norway. HR used the occasion to explain the mechanisms that have been used in the development of previous encyclopedias. She especially emphasized the need for a stringent time table and the requested formats in which the final articles should be submitted. It was also agreed that most if not all of the correspondence dealing with EoAS should go via e-mail. Further, the main editors agreed which of twelve sections would fall under their individual responsibility.

1.3. Contributions

From then on the major assignment to the section editors was to commission and encourage authors to write for the section. At their discretion and to facilitate the work of the section editors, the main editors made auxiliary lists of potential authors for specific articles. Again attempts were made for a wide geographical spread and for decent representation of academics and people from practice.

HR took care of the signing of the contracts by the SEs recommended by JT and BS and dealt with a number of further technical matters. A spreadsheet was created to keep track of all articles and contributors. To facilitate the production process, each article received a seven digit identifier that indicated its location in the final encyclopedia. Contracts out and back were logged as were draft and final manuscripts once accepted by the SEs, JT and BS. All SEs, JT and BS were regularly updated with progress to keep the momentum going. This spreadsheet was later extended to include aspects of the production process. Contributors were also provided by HR with instructions about format and time scales.

On September 2002 the main editors met with HR on the occasion of the *Second Conference on Actuarial Science and Finance* organized by the Department of Statistics and Actuarial Science at the University of the Aegean on the Greek isle of Samos. Key problems were raised and solutions developed. Some of the section editors asked or needed to be replaced and alternatives were sought. Overall the project looked in pretty good shape. It was decided to not wait too long before having a second meeting. This then took place at the Wiley offices in Chichester on 21 and 22 March 2003.

At the meeting in Chichester a decision was made for the more-or-less final master list of topics that needed to be included. It was realized that already a fair percentage of the requested articles had been finished. However, as can be expected from a work of this size, there remained a number of essential gaps (articles as well as authors) while some rationalization of other articles was necessary. The most important task for the main editors was the further inclusion of all the articles into one single encyclopedia. This is done via cross-referencing, a task that would consume a substantial amount of time and energy from the main editors. Fortunately, some of the section editors have been so kind to help substantially in this activity.

By March 2004 only a small number of articles was still missing because the agreed authors did not deliver. As a final initiative the editors approached alternative authors for the most important lacunae.

1.4. Production and Marketing

As soon as a section editor received an article for his/her section, he/she would control whether it fitted the requested content and format. If yes, the article would then be sent to HR at the Wiley office as well as to JT or BS who took care of the proper cross-referencing. The final articles

were processed by Laserwords in India and HR's involvement diminished to answering queries, mainly about copyright issues and possible permissions from other publishers. HR maintained a page count for each article.

Whilst production was in process Wiley's marketing department swung into action. A Website was created, leaflets designed, printed and circulated. All major societies were contacted and several cooperated in promoting the encyclopedia. International sales force included the encyclopedia in their portfolios to libraries, agents and bookshops.

In productions like these that there is close cooperation between editors/authors and the publisher, each concentrating on their own areas of expertise. It is also important to maintain constant communications between everyone involved. This ensures a scientifically excellent, commercially successful and timely publication.

In September 2004 the EoAS was published as a three volume set. In September 2006, an online version of the Encyclopedia was launched on Wiley InterScience (see www.mrw.interscience.wiley.com/eas), which utilizes sophisticated linking and searching functionalities to further enhance the usefulness of the Encyclopedia.

2. The Different Sections

Apart from some auxiliary items that will be discussed in a later section, the main bulk of EoAS consists of 452 articles, spread over 1842 pages. The articles are arranged in alphabetical order even when the commissioning was done using the different sections. The originally planned *Section 13: Extra* fortunately contained so few articles that they could be easily amalgamated in one of the other 12 sections.

Here is the final list of these sections in alphabetical order with some information on each one of them. Apart from the number of articles in the section we mention names and affiliations of the section editor(s). We also give a few highlights of the content of each section.

(1) **Claims Distributions**
   - Number of articles: 41
   - Section Editor: Gordon WILLMOT, Department of Statistics and Actuarial Science, University of Waterloo, Ontario, Canada
   - Main highlights: The main emphasis is on a broad coverage of distributions, applicable in actuarial science: parametric, discrete and continuous distributions in one and more variables, with special mention of extreme value laws, phase-type distributions and the Sundt-Jewell class. Aggregate loss and individual risk models fit into this section. Elements dealing with dependence (like copulas) and recursions are treated as well.

(2) **Collective Risk Theory**
- Number of articles: 19
- Section Editor: Elias SHIU, Statistics and Actuarial Sciences, University of Iowa, USA
- Main highlights: Claim number and claim size processes form the backbone of collective risk theory that deals with risk processes and in particular with the theory of ruin, its probability, time and severity.

(3) **Direct Nonlife Insurance**
- Number of articles: 62
- Section Editors: Gary VENTER, Guy Carpenter Instrat, New York, U.S.A. & Greg TAYLOR, Taylor Fry Consulting Actuaries, Sydney, Australia
- Main highlights: Among the many forms of nonlife insurance we mention the portfolio's: accident, aquaculture, automobile, aviation, burglary, crop, earthquake, liability, finance, loss-of-profit, fire, home owners, marine, property, sickness, travel and worker's compensation.

(4) **Economics**
- Number of articles: 28
- Section Editors: Michel DENUIT, Institut des Sciences Actuarielles & Institut de Statistique, Université Catholique de Louvain, Belgium & Marco SCARSINI, Dipartimento di Statistica e Matematica Applicata, Universitá di Torino, Italy
- Main highlights: Game and utility theory provide basic economic frameworks that are dealt with in detail. Market theory is treated together with effects like fraud, risk aversion, free riding and risk sharing.

(5) **Finance**
- Number of articles: 36
- Section Editor: Andrew CAIRNS, Actuarial Mathematics and Statistics, Heriot-Watt University, Edinburgh, Scotland
- Main highlights: Market models such as Black-Scholes and Wilkie's model make up a substantial part of this section that also deals with dynamical financial analysis and financial engineering. Among the different aspects of risks we mention credit risk, foreign exchange risk, interest rate risk, risk measures (i.a. value-at-risk) and risk management via hedging and derivatives.

(6) **Life, Pension & Health Insurance**
- Number of articles: 44
- Section Editor: Angus MACDONALD, Actuarial Mathematics and Statistics, Heriot-Watt University, Edinburgh, Scotland

- Main highlights: Aside from pension issues, this section deals with special portfolio's like disability, group life, health and long-term care. Practical aspects like annuities, life tables and social security are treated as well as supporting topics as demography and mortality.

(7) **Organizations, Journals & History**
- Number of articles: 93
- Section Editor: Jean LEMAIRE, Insurance and Risk Management Department, Wharton School, University of Pennsylvania, Philadelphia, U.S.A.
- Main highlights: Most of the existing national actuarial societies have submitted an item for this section. Also the international actuarial bodies are well documented. Information is provided on the traditional actuarial journals. Historical articles are included on actuarial education and professionalism as well as on two dozen of the most important people from academia and practice who have left a mark on the development of actuarial science.

(8) **Premium Calculation, Nonlife**
- Number of articles: 11
- Section Editor: Shaun WANG, SCOR Reinsurance Company, Ithaca, Illinois, USA
- Main highlights: This section deals with premium principles, bonus-malus systems, experience rating, credibility theory and the ordering of risks.

(9) **Probability Theory**
- Number of articles: 47
- Section Editor: Sören ASMUSSEN, Department of Theoretical Statistics, Aarhus University, Denmark
- Main highlights: This supporting section deals with a variety of stochastic processes that have shown their relevance within actuarial science: counting processes (like point, renewal or Poisson processes) are treated as well as martingales, Markov, diffusion and Lévy processes. Queueing, fuzzy set, central limit and extreme value theory are covered. Important methods like MCMC, Itô calculus and coupling are handled as well.

(10) **Reinsurance**
- Number of articles: 25
- Section Editor: Maria de Lourdes CENTENO, Instituto Superior de Economico e Gestão, Universidade Técnico de Lisboa, Portugal

- Main highlights: The main types of reinsurance are treated in detail: Excess-of-loss, proportional, quota share, stop-loss, surplus and treaties based on extremes. Specific applications to life, catastrophes and finance are covered.

(11) **Reserving, Nonlife**
- Number of articles: 10
- Section Editor: Richard VERRALL, Department of Actuarial Science and Statistics, City University, London, UK
- Main highlights: Claims reserving in non-life insurance is treated by credibility methods and Bayesian theory. The chain-ladder and separation methods are duly covered as well as reserving based on the Kalman filter.

(12) **Statistics**
- Number of articles: 36
- Section Editor: Josef STEINEBACH, Mathematisches Institut, Universität zu Köln, Germany
- Main highlights: This section deals with those statistical concepts and methods that have a strong influence on actuarial science. Methods that are given are: Bayesian, parametric, non-parametric, regression and time series. Reliability, neural networks and survival analysis are treated as well as information on splines, outliers, competing risks, censoring, frailty, resampling and robustness.

3. CONTRIBUTORS

While the breadth of the encyclopedia can be appreciated from the vast table of contents, its depth has been guaranteed by the choice and competence of the wide slate of renowned experts on different aspects of actuarial science. From the adjoining table one realizes that serious attempts have been made to include authors both from academia and from financial institutions. Authors are coming from 43 different countries. Let us make a number of observations.

- For obvious reasons the United States, United Kingdom, Australia and Canada have the strongest representation.
- Looking at the column of academic people, one notices that other countries with a strong and historical education in actuarial science are well represented. This is specifically the case for Belgium, Canada, Denmark, Germany and Sweden.
- When a country has only one author most often he/she was involved in the article dealing with the actuarial association within that country.

COUNTRY	ACADEMIA	BUSINESS	TOTAL
Argentina	0	5	5
Australia	10	16	26
Austria	2	1	3
Belgium	10	4	14
Brazil	0	2	2
Canada	16	3	19
China	1	0	1
(Hong Kong)	3	2	5
Croatia	0	2	2
Cyprus	0	1	1
Czech Republic	0	3	3
Denmark	10	3	13
Estonia	0	1	1
Finland	2	2	4
France	4	4	8
Georgia	0	1	1
Germany	18	4	22
Ghana	0	1	1
Greece	4	1	5
Hungary	0	1	1
Iceland	1	0	1
Israel	1	1	0
Italy	1	1	2
Japan	0	1	1
Latvia	0	1	1
Malaysia	0	1	1
Mexico	1	4	5
Netherlands	6	2	8
New Zealand	0	1	1
Norway	6	7	13
Pakistan	0	1	1
Poland	3	1	4
Portugal	1	2	3
Romania	1	0	1
Singapore	0	1	1
Slovakia	0	1	1
Slovenia	0	1	1
South Africa	3	0	3
Spain	2	1	3
Sweden	7	2	9
Switzerland	3	9	12
Taiwan	1	1	2
Ukraine	0	1	1
United Kingdom	23	8	31
United States	35	38	73
TOTAL	**175**	**142**	**317**

- Because of its long tradition in financial institutions also Switzerland has a strong representation on the business side.

- We have listed Hong Kong on a separate line even when it belongs to the People's Republic of China. However, looking at the table one realizes that Hong Kong has a long tradition in the financial and insurance world.

4. Informational Elements

Each volume starts out with three lists.

- *(i)* The **Editorial Board** on pages $v - vi$;

- *(ii)* the **Contents**, listing all articles in alphabetical order on pages $vii - xii$;

- *(iii)* the list of **Contributors** in alphabetical order on pages $xiii - xix$;

- *(iv)* a long list of **abbreviations and acronyms** on pages $xxv - xxxiv$. Like in most other technical subjects, actuarial scientists use a great variety of abbreviations and acronyms. Rather than including them in the subject list, the publisher collected the list in the starting pages of each volume. Some of the very crucial abbreviations (like CAPM, DFA, LIBOR, etc.) are still repeated in the subject list (see 5.2).

5. Indexes

To facilitate the use of EoAS, two indexes have been included. We give a short discussion of each of them.

5.1. Author Index

A first list on pages 1769-1772 deals with the location of the contributions made by the different authors. Boldface letters refer to the volume while the other figures indicate the precise pages on which the contribution can be found. One notices that some authors have been extremely productive.

5.2. Subject Index

This list on pages 1773-1842 is included at the end of volume 3 and is crucial to the entire encyclopedia. For this reason its length exceeds 35 pages. Here are some of its uses.

- Of course, the list contains all articles for which there is a separate article in the EoAS. However, this is not the main function of the list as the EoAS is built up alphabetically anyway.

- A number of actuarial concepts carry different names in different environments while being essentially the same. For example, C-2 risk in USA is the same as insurance risk in UK. As the encyclopedia was intended to be of use worldwide, it was necessary to include both items somewhere. So, one name is included in the alphabetical list while the other is also taken up in the subject list with a reference to its treatment in the alphabetical list.

- The list is also intended to indicate to the reader *all* articles where a concept has been vitally used. Sometimes, such a reference may be novel to the user.

- Sometimes the boundaries between the different sections is rather diffuse. In such cases the article was assigned to one specific section only. A reader interested in the article but from the point of view of the other section should be able to properly trace the subject thanks to the subject list.

6. Guidelines

Apart from the indexes, there are a number of elements that should help the user of EoAS. We add a few thoughts on each of them.

6.1. Preface

Creating EoAS has been really challenging. The preface, repeated in each volume on pages $xxi - xxii$, explains the goals laid out at the conception of EoAS and the procedure followed in realizing its goals. As the encyclopedia was intended to be of help to academic researchers as well as to people in practice, EoAS leaves ample room for established tools based on practical experience in insurance companies as well as more theoretical results developed in academic environments.

6.2. Cross Referencing

The procedure followed in EoAS for cross referencing is briefly outlined on page $xxiii$ and has been the same as for previous encyclopedia's like [1] and [2]. The main goal of the referencing system is to take care that everything necessary will be covered. There are four types of cross reference:

(1) something within the text which is emboldened but is not necessarily the exact title of another article,

(2) also in the text but (see XXX) where XXX is the exact article title,

(3) at the end of the article (see also XXX),

(4) and not an article at all but XXX see YYY.

As explained before, the actual referencing has been done by the main editors together with the Wiley people.

6.3. ARTICLE STRUCTURE

Most articles of some length contain the following information, not necessarily in this order.

- The *abstract* gives a summary of the article and its role within EoAS.
- Then comes the *main body*, almost always structured according to the rules followed by scientific writing.
- At the end of the article, the *conclusions* indicate how the article has fulfilled its task.
- An extremely important part of any article is a list of *references*, guiding the user to the relevant literature that should cover the most recent developments. Sometimes the author even gives the user indications on *further reading*.
- *Related articles* refer the reader to other articles in EoAS where similar or/and related concepts are treated.

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