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## THE CALCULATION OF THE FIRST LIFE TABLE: A HISTORICAL NOTE

by Robert Schoen

The first life table, or life table model, was produced in 1662 by John Graunt in his *Natural and Political Observations*. That brief, crude table was both inaccurate and unrealistic. It implied an expectation of life at birth of only 17.5 years and a Total Fertility Rate of about 8 in the stationary life table population. Nonetheless, it proved to be the source of one of the most powerful concepts and valuable tools in demography and actuarial science.

It has been the subject of a considerable amount of speculation as to how Graunt arrived at his figures. After gauging from his data that about 36 of 100 live births die before the age of 6, and guessing that only one survived age 76, Graunt "sought six mean proportional numbers between 64, the remainder, living at six years, and the one, which survives 76, and finds, that the numbers following are practically near enough to the truth; for men do not die in exact Proportions, nor in Fractions" (See Table 1).

Graunt's description of his method has been found wanting. Major Greenwood (in "Graunt and Petty", *Journal of the Royal Statistical Society*, Vol. XCI, Part 1, 1928, p. 82) observed that a constant ratio of .62 would give a good fit. W. F. Willcox, in his introduction to the 1939 edition of Graunt's book, suggested that Graunt might have experimented with the fraction  $\frac{5}{8}$ . M. Ptoukha (in "John Graunt, fondateur de la demographie", *Congrès International de Population* Paris, Vol 2, 1937, p. 71-72) advanced the idea that Graunt may have used a factor of .63. D.V.

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## 20th INTERNATIONAL CONGRESS OF ACTUARIES

There are 85 United States Actuaries who have already registered for the Congress which will meet in Tokyo from October 25 through November 1, 1976. The Organizing Committee of the Congress has announced that it will accept additional registrations for the Congress for a few more weeks. Registration is open to all members of the International Actuarial Association. (If you are not already a member, see the last paragraph for information on joining the I.A.A.)

The United States Section of the I.A.A. is sponsoring two package tours in conjunction with the Congress (15 and 22 days). Attractive rates for air fares, hotels and land arrangements are being offered to allow members to attend the Congress and then see some of Japan and other parts of the Orient.

Hard-bound copies of the *Transactions* (papers submitted for the Congress) will be available to anyone wishing a set. The price will be 18,000Yen (approximately \$60), with delivery in Spring, 1977. Participants will receive paper bound copies and may purchase hard bound copies at the same price.

If you are interested in the Congress or would like to order a copy of the *Transactions*, please contact Fred Rathgeber (Prudential Plaza, Newark, N.J. 07101) no later than March 26.

## THE NORTHERN ROUTE

by Kenneth T. Clark

This is a report of recent activity in Canada of that phenomenon which is called the "alternative route" by careful users of the language, which is called the "alternate route" by persons not falling into that category, and which therefore is called the "alternat route" by the vast majority of North American actuaries. For this report, the abbreviation "AR" is safe.

First, the background. The Garber committee of the Society of Actuaries has recommended a method of implementing the AR if the Society and the other sponsoring actuarial bodies want an AR. The Society has accepted the report in principle and put it before the other sponsoring bodies for discussion. The discussion is still going on. Briefly, the method recommended by the Garber committee is that a student will be granted Associateship if he takes the right courses at one of the right universities, gets the right grades, and passes one Comprehensive Society examination covering all the Associateship material.

In Canada discussion of an AR has been stimulated in other ways as well. Our actuarial education and examination have traditionally been in English only. But Canada is a bilingual country and we want to have education and examination in French too. Obviously, this will take a lot of work. Perhaps some of it can be avoided by making greater use of the universities, where a choice of language already exists.

It may be easier to implement an AR in Canada than in the U.S.A. In Canada, the actuarial population is concentrated in a few places. So are the universities with actuarial programs, and

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ould teach at new actuarial programs. In order to keep their jobs, these teachers would feel pressure to grade easy. Insurance companies and consulting firms will, of course, be able to reduce salaries, but they will eventually find the average bogus-associate just isn't as bright as the regular kind.

Thomas G. Kabele

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"The Proper Study. etc."

Sir:

Obviously, Mr. Jenkins (December 1975) has not been faced with the problem of hearing the words "Well, you certainly don't look like a fellow" at least once a month. This is the usual retort a female F.S.A. encounters upon being introduced as a Fellow of the Society of Actuaries to a new acquaintance, unfamiliar with the actuarial profession.

I, personally, would like to see the designation F.S.A. changed, but have been unable to arrive at a suitable alternative. "Full Member" versus "Associate Member" does not sound quite right.

I agree that the "person phobia" can be carried to extremes. However, changes in our society have often been accompanied by changes in the language. And, if the use of words like "Police Officer" vs. "Policeman" makes it easier for a young girl to visualize her future entry into such a career, then why delay progress with words?

Alice Rosenblatt

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Sir:

Mr. Jenkins's letter in the December issue hits the nail right on the head. It leads me to wonder who in the Society authorized the use of "Chairperson" and "Co-Chairperson" to denote those who preside at workshops. Was it the Board of Governors? I don't recall anything in the reports of the non-routine actions of the Board. Could this be one of those ominous unreported "routine" items?

Maybe it was the Program Committee. However, I just got a memorandum from the Vice-Chairman (sic) of the Program Committee, addressed to me as

Chairperson (sick) of a workshop. Surely the Committee would not itself create such an inconsistency. After all, sauce for the goose is sauce for the gander, if you will pardon a proverb so sexist.

As Mr. Jenkins suggests, let's quit this verbal nonesense. There are better ways to promote the siblinehood of personkind.

Kenneth T. Clark

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Calculation of First Life Table

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Glass, in his essay on "Graunt's Life table" (*Journal of the Institute of Actuaries*, Vol. 76, 1950, p. 60-64), described an involved calculation procedure based on differences in the distribution of deaths. The problem is that neither .63 nor  $\frac{5}{8}$  nor .62 will generate the remaining survivorship ( $l_x$ ) values of Graunt's life table. Glass' method will, but seems to be much more complicated than the method than Graunt had in mind.

As I have not seen it elsewhere, I would like to suggest another approach as possibly having been Graunt's method. If Graunt started with the numbers 100 and 64, or a factor of .64

dropping fractions at each step he would have produced the figures shown in column (6) of Table 1. The figures generated by the three alternative factors mentioned, .63,  $\frac{5}{8}$  and .62 are given in columns (3), (4) and (5) of the table.

There does not seem to be any simple rule for rounding or adjusting the values produced by either .63 or  $\frac{5}{8}$  or .62 to arrive at Graunt's figures. However, adopting the rule of dropping all fractions will yield Graunt's  $l_x$  values from the figures generated by a factor of .64. Thus it is possible to reproduce all of Graunt's numbers in a manner wholly consistent with his account, including his observation that men do not die in "Fractions", and that his figures are "practically near enough to the truth."

Calculating a life table  $l_x$  column by the use of a constant factor implies that the probability of a person surviving one year, the probability of a person dying within one year, and the force of mortality are all constant, features that are not realistic. The simplest improvement would be to replace a constant force of mortality  $\mu_x$  by an expres-

sion such as  $\mu_x = \frac{1}{80-x}$  so that  $\mu_x$  would

increase steadily with age. Yet it took over 60 years before DeMoivre proposed it in 1724, as part of an attempt to represent the  $l_x$  curve by a straight line.

Table 1

The survivorship ( $l_x$ ) column of Graunt's original life table and different approaches to its reconstruction.

(1)	(2)	(3)	(4)	(5)	(6)
Age	Graunt	".63"	". $\frac{5}{8}$ "	".62"	".64"
(x)	$l_x$	$l_x$	$l_x$	$l_x$	$l_x$
0	100	100	100	100	100
6	64	63	62.5	62	64
16	40	40.32	40	39.68	40.96
26	25	25.2	25	24.8	25.6
36	16	15.75	15.625	15.5	16
46	10	10.08	10	9.92	10.24
56	6	6.3	6.25	6.2	6.4
66	3	3.78	3.75	3.72	3.84
76	1	1.89	1.875	1.86	1.92
80	-	-	-	-	-

The  $l_x$  values in columns (3), (4), (5), and (6) were calculated by taking the  $l_x$  value in column (2) at the next lower age and multiplying it by factor indicated.