New Procedures

Are there new ways of using computers in connection with various aspects of actuarial work, such as:

(i) New techniques for the calculation of premium rates, dividends, reserves, and nonforfeiture values;
(ii) The development of model offices, other simulation procedures, and other types of Operations Research application;
(iii) The preparation of interim accounting statements which reflect current month-by-month results by line and area of operations?

MR. JOHN W. LINCOLN: At the Northwestern Mutual we have a values subroutine which calculates net and gross premiums, reserves and dividends for any policy ever issued by the Company. The routine was long in writing—for one thing, great attention was given to economy of space and time. It utilizes 18,000 memory positions.

The routine operates under any one of several "modes," which means that it will calculate any combination of premiums, reserves and dividends. For example, by keying in mode "G" the routine will assume that the correct premium and reserve is stored and will figure only the dividend. When sequential values are being figured, time-saving repetitive modes are used.

During the year since it was completed, we have used the routine in six basic applications:

1. The updating of our master file to put on new reserve and dividend factors for the coming year.
2. The day-to-day payout of dividends on policies as yet unconverted to magnetic tape.
3. Calculation of the year-end dividend liability.
4. Calculation of basic values and dividend illustrations for the rate book.
5. Calculation of dividend factors for existing policies for the dividend manual.
6. As of last Friday, it is an integral part of our newly installed input edit runs which, among other things, puts all the premium, reserve and dividend factors on new master records going on tape.

In addition, the routine has been used for various occasional purposes, including the figuring of experimental dividend scales.

The value of the routine lies in the avoidance of duplication of effort, and also in avoiding situations where the dividend in your rate book is sometimes a penny off from the dividend in your manual or the one you're paying out. Also, very substantial savings in machine time have been realized.

MR. JAMES J. CONNORS: I am not sure that we at New York Life have developed any radical *new* techniques, but we have made some changes from our old techniques.

In the calculation of various rates, when we started our computer operations in 1956 with the IBM 705 we built up large tape files of rates for all durations. When we needed rates we had to run this whole file to extract the particular cells we wanted. We recognized that this was unwieldy, but it took us a while before we could spare the time and talent necessary to develop a generalized set of programs that would calculate from first principles any rates desired. With this new system, which we put into effect in 1959 and which we have been expanding ever since, we can calculate in a relatively short machine run only the rates we need when we need them. This not only saves time but provides us with a much greater degree of flexibility in that we can easily calculate rates on any proposed new basis for test valuations or for research purposes. We have also done some work using the 705 to independently check reserve and net premium rates by summation checking and other techniques. For further verification of rates we have developed "inspection" programs to check the "grading" of values from age to age or duration to duration. This has proved especially helpful in the inspection of rates and values that are to be printed for rate books and dividend illustrations.

I should mention that we have a brand new procedure for developing these rate books and dividend illustrations. For several years now we have been printing these by a photo-offset process from 705 output but, since the formats always seem to change each year, the programs for assembling the pages had to be either rewritten or substantially modified for each booklet. Now we have a generalized procedure where the printing layout is coded for input to a 705 compiling program, and this compiler generates the actual operating program for preparing the booklet. With this new procedure we can print all sorts of booklets with a minimum amount of effort.

We haven't as yet done much on the 705 in model offices, simulation or operations research. However, one point that may be of interest is that, by making use of the speed of the machine and the design of our operations, we have been able to use our in-force summaries as model offices. Thus, if we want to test the effect of a proposed change in reserve basis we simply calculate the new rates on the generalized program that I mentioned previously, and run the rates against our in-force summaries, using our regular valuation program. The results are available faster and are more accurate than would be the case if the test were done manually using a small model office.

MR. RUSSELL M. COLLINS, JR.: In determining its 1960 dividend scales, The Minnesota Mutual employed a technique which would have been impractical without the use of an electronic computer. We have always made asset share calculations to test the adequacy and equity of proposed dividend scales. However, these proposed scales were based on a formula which reflected the relative contribution of each dividend class to earnings—in our case, the experience premium method. In 1960 we programmed our electronic computer to make asset share calculations. The high speed with which the computer can make these calculations, coupled with the ease with which input to the program can be changed, enabled us to develop our dividend scales directly from asset share considerations; that is, we started with initial scales with the desired properties (with the reference to slope, competitive position, etc.) and modified these scales on line to produce asset shares which were both adequate and equitable as between dividend classes.

Input for each policy year was not necessary. The computer was able to develop data for each policy year from program and constants stored at the beginning.

MR. HUGH G. JOHNSTON: The use of computers has given the actuary a greater freedom in determining the basis to be used for the calculation of his premium rates, dividends, reserves and nonforfeiture values. No longer is he limited to published tables (as often was the case); if he wants to use an odd rate of interest such as 3.65%, he can do so readily. Another advantage that we have found is that it is now relatively simple to compute reserves on different bases simultaneously, which is most helpful.

MR. YUAN CHANG: The most suitable computer for some types of actuarial work would combine the high input-output speeds of the business computer with the high computing speeds of the scientific computer. For most insurance companies, only the business computer is available.

While it is feasible to calculate reserves from first principles, using mortality rates and interest factors, the amount of machine time required will, in most cases, prove to be too expensive.

The use of commutation columns will reduce the amount of computing time required, but places an emphasis on the order of the master file, because of the multiplicity of valuation bases. The use of rate tapes containing reserve factors also places an emphasis on the order of the master file.

At The Travelers, we plan to revert to an old technique which nobody in his right mind would have used 20 years ago. Individual records will be carried in our file for each basic policy and for each supplemental benefit.

Each record will include the net premium and terminal reserves for all durations. Annually, the net premium and the two appropriate terminal reserves will be used to determine the required reserve figure for each record. The file will be updated monthly, and at the end of the year we can tally the reserves in any order we like.

Advantages of this system are (1) a large cut in calculation time, (2) it permits freedom in file order and a flexible distribution system, and (3) it separates the actuarial function from the data processing, because once the reserves are established, any subsequent distribution can be handled by nonactuarial personnel.

Disadvantages are: (1) a lengthy record; and (2) recalculations are needed if reserves are to be strengthened or destrengthened. We also have a problem in setting up our master file initially.

MR. WILLIAM A. MACOMBER, JR.: The Prudential over the past few years has utilized a number of operations research techniques, but perhaps most interesting to actuaries is our use of linear programming to create model offices representing our Ordinary premium paying life insurance in force.

Model offices are frequently constructed to represent life insurance in force. By substituting a manageable number of plan-age combinations for thousands of such combinations actually in the in-force, we actuaries are able to project quite easily items such as amount of insurance in force, reserves, and premium income many years into the future.

Traditionally model offices have been constructed from only 3 or 4 common plans at 3 or 4 different issue ages. However, gross premiums in force or reserves or other characteristics of a model created in this manner might not correspond well to the actual characteristics of the in-force.

In our approach to model construction we did not limit ourselves to so narrow a range of plan-age combinations. In our first step we selected 100 to 200 cells as possible components of each model. These cells were combinations of age at issue, mode of premium payment and plan. The cells varied also by premium band or year of issue for some of the models. Only plans comprising more than 1% of the in-force to be represented by the model were used. We restricted the issue ages used to those for which asset shares had been computed.

The in-force to be represented was measured for a number of characteristics which we desired to have the model reproduce. These characteristics were either important in themselves or were thought to be helpful in obtaining a broadly representative model. Among the characteristics used were the following:

life insurance mean reserves
amount of insurance in force
number of policies in force
amount of gross premiums in force
amount of net deferred premium assets
amount of insurance schedule to be paid up within 5 years, and within 10 years
amount of endowments scheduled to mature within 5 years, and within 10 years
amount of term insurance scheduled to expire within 5 years, and within 10 years
amounts of insurance by issue age groups
amounts of insurance by mode of premium payment
dividends apportioned.

The job of linear programming is to pick from the 100 to 200 cells to which I have referred a smaller number weighted in such a manner as to reproduce the characteristics selected. For each characteristic, each cell has a value per $1,000 of insurance. Thus we have an equation for each characteristic, the value of the characteristic for the entire in-force being the right-hand side of the equation. On the left-hand side, the unknowns are the cell weights which satisfy the equations. For a typical model we might have, therefore, 150 unknowns and 20 equations. There may be an infinite number of solutions or no solutions for which all values are non-negative. We don't want to have a negative in-force for any cell. By linear programming, a 705 computer obtains a solution, in this hypothetical example, for which 20 or fewer of the cells' weights have positive values and all the rest are zero. In most cases the model reproduces exactly all of the selected characteristics of the in-force. When some of the characteristics are not exactly reproduced, the solution obtained is the one which most closely reproduces all of the characteristics.

In all, 35 models were created. We constructed separate models for each year of issue commencing with 1935. For earlier years, models were constructed for groups of years of issue within major valuation bases.

We have used our models to project through 1970 such items as the following:

amount of insurance in force
net premiums in force
gross fractional premiums in force
gross annual premiums in force
mean reserves
cash surrender payments
death claim payments
annual dividends paid
termination dividends paid
premium income
commission payments.

We have developed a system utilizing a 650 computer capable of projecting simultaneously about 40 different variables. However, it is most likely that future applications will be limited to projection of a relatively small number of variables at one time.

We feel that projections from model offices created by linear programming are likely to be more accurate and realistic than projections from model offices constructed by traditional methods, since we can reproduce many more characteristics of the in-force with linear programming. It is difficult to prove that we are correct in this feeling because the accuracy of our model projections also depends on good forecasting of issue and of lapse and mortality rates. However, there are several reasons for our belief. First, many of the characteristics that we reproduce are those that will be projected, thus insuring that we start off the projection period with correct amounts. Second, other characteristics that are reproduced control the future behavior of the in-force. For example, we force the model to have the same proportion of endowments maturing within 5 years as the actual in-force has. Third, since we control characteristics of the in-force such as reserves we are likely to get better projections of related items such as cash surrender payments and termination dividends paid than would be obtained without such control. Finally, it is our intuitive feeling that the more characteristics of the present in-force we reproduce in our models, the more likely we are to get better predictions of the future.

MR. RALPH H. GOEBEL: Most companies apparently feel, in this day of sharpened competition, that some policies such as juvenile and term contracts need not make a full contribution to company overhead. The conventional asset share approach does not take this factor into account. At the Northwestern National, we plan to test the rates for our new rate book by using model offices with varying product mixes. Certain overhead expenses will be handled as a lump sum in this model office, regardless of the product mix or volume of insurance. Direct policy expenses will, of course, be included on a unit basis.

We feel that this model office approach will also give us a more correct answer on the cost of lapses, since the possibility exists that certain items of overhead will remain fixed and that only the direct expenses due to a lapse should be considered. We also intend to introduce not-taken rates, and to make various assumptions as to distribution of business by mode of premium. For federal income tax we will attempt to reflect the present law as accurately as possible.

The work I have outlined is a current undertaking which will be done using the IBM 7070. Upon reaching satisfactory results from the first

round of work we plan to broaden the model office and introduce refinements in isolated areas of the program, possibly computing the mortality by Monte Carlo techniques.

MR. A. CHARLES HOWELL: To provide guidance for the selection of interest assumptions for new premium rates, we had developed an IBM 1620 program last summer which produces what I would call an investment model for our group annuity operation at the John Hancock.

The variables in this program are (1) the current rate of interest on new investments, (2) the rate of decline or increase in the rate of interest obtainable on new investment, and (3) the rate of reinvestment. Variations in the amount of funds to be invested with the economic cycle, volume of new premium income, or unusual payouts can also be taken into account.

The results obtained were rather interesting. For example, the interest rate that could be used in the calculation of an immediate annuity can be close to the new money rate, because dollars that would have become available for reinvestment are actually paid out to the annuitant.

On the other hand, dollars which are received at a young age, say at 25, and continued over a long lifetime, would eventually come out to an average rate very close to our portfolio average.

The main objective of the program was not to decide on a rate which was exactly appropriate but to create a model for our business under differing sets of assumptions as a guide for our management.

MR. CONNORS: In regard to the preparation of interim accounting statements, we have been preparing monthly policy exhibits, monthly paid issue statistics and quarterly valuations on the 705 for quite some time. In addition, as a by-product to the assembly of our contribution to the L.I.A.M.A. first year lapse survey, we are producing a "rough and ready" monthly lapse index which will provide a convenient means of looking at current lapse trends. We are also providing interim reports on marketing statistics. Each quarter we prepare sales analysis and performance reports for each field office, providing a variety of statistics relating performance to goals. This procedure is being extended to provide statistics by type of agent and by individual agents and should prove to be very valuable for management information and control.

MR. ROBERT G. ESPIE: I would like to make one semifacetious and semiserious comment. At the Aetna we have, in some areas, been preparing monthly statements by hand or by punch-card machines for a long time. We present these to management, who, in turn, ask for explanations of certain figures. We might find, for example, that the reason that claims

were higher this month than last is that this month has 31 days, whereas last month had 28. We also have trouble with the Thanksgiving weekend when the claims department shuts down. We think we can get real advantage from a computer because we may be able to put some of this work on the machine and convince management it just isn't possible to do it more often than quarterly. We think there could be a real saving here.

MR. J. RAE JAMIESON: A number of companies are using large-scale computers for their policy issue work, or for most of it. At least one company is actually writing the policies in continuous form on computers, and I understand they are doing it very successfully.