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ELECTRONIC DATA-PROCESSING AND OPERATIONS RESEARCH

Electronic Data-processing

A. How are computers being used for
   i. Underwriting of individual policies;
   ii. Mortality and morbidity studies, including the derivation of exposures, analysis of claims, graduation of results;
   iii. Selection and maintenance of an investment portfolio;
   iv. Group insurance, pension, and other employee benefit plan operations;
   v. Payment of claims and maintenance of claim data for individual health insurance;
   vi. Aids to the sales force, such as for insurance programming or conservation?

B. What considerations are involved in the decision as to whether to replace existing computers by computers of a new generation? Is the development of new computers so rapid that replacement or expansion of equipment occurs before the break-even point? Have cost savings actually developed as originally expected? When equipment is replaced, what problems are involved in
   i. Retraining personnel;
   ii. Revision of programs;
   iii. Revision of operating procedures?

C. Are daily runs of master record files now feasible for very large companies? Does "real-time" access to central electronic information storage hold any economic promise for life insurance?

D. What is the basis of allocation of
   i. Developmental and programming costs;
   ii. Operating costs?

   Recognizing the higher degree of interrelation of functions within data-processing systems that are based on computers, how can the unit costs required for a functional cost system be derived?

E. Have any problems arisen for governmental insurance department examiners because of electronic data-processing systems?

MR. GEORGE E. WALLACE: The John Hancock has four subdivisions of its individual life policies: (*a*) weekly premium industrial; (*b*) monthly debit ordinary ($5,000 maximum); (*c*) multiple protection series ($5,000 maximum); and (*d*) select series ($5,000 minimum).

Underwriting by computer has been applied to these areas beginning with weekly premium industrial in 1962, monthly debit ordinary in Sep-

tember, 1963, and multiple protection series in February, 1964. An experiment is being conducted now in the under $10,000 range of the select series.

The percentage of cases approved entirely by the computer ranges from 90 per cent for weekly premium industrial to 70 per cent for monthly debit ordinary and 60 per cent for multiple protection series. Incomplete results on the select series indicate more than 50 per cent.

The main advantages are: (*a*) consistency, (*b*) job enhancement, (*c*) confidence in the results, and (*d*) increased speed of issue. The main disadvantage is the effect on the program of errors in preparing input.

With respect to mortality and morbidity studies, exposures have been obtained for several years by extracting data from the master tape file as it exists at the end of each calendar year.

Data are extracted for company purposes and for contribution to the Society's Intercompany study at the same time. It is assumed that a policy in force on December 31 is exposed for a full policy year.

Deaths are recorded as a by-product of the claim operation and the regular updating system. Exposures are adjusted for deaths which have already occurred within the policy year before December 31.

Exposures involving build, blood pressure, medical impairments, and occupation are obtained from a supplementary card file (processed by computer). This file contains all substandard cases, conversions, pension trust, Association cases, and similar groups, as well as a sample of policies issued standard.

Wherever results are to be graduated, a computer program applies a Whittaker Henderson Type B formula to the raw data. The solution to the set of simultaneous equations is arrived at by a method of successive approximations, and the results have been satisfactory. This original program has undergone a series of refinements during the past few years.

Very little has been done on analysis of claims by computer.

MR. GEORGE L. HOGEMAN: The Aetna has made a start at using electronic data-processing for underwriting individual policies.

As each application arrives in the home office, all the essential data regarding the case are punched on a single eighty-column punch card. These cards are accumulated and sent to the computer five times daily.

First, the computer extracts from its memory those underwriting rules pertinent to the application on the basis of age, amount, and plan. These rules are printed out for attachment to the folder. Currently, the computer applies only a single rule; it tests whether the application is within nonmedical age and amount limits and prints out its finding.

Next, the computer prints out certain information extracted from its memory relating to agent, examiner, age, and the underwriting value of the case. This value has been computed for every combination of age and plan and is the present value of the future amounts at risk discounted for mortality, lapses, and interest. The value is the basis for calling for additional information and referring the file for additional attention.

The computer also is used to supervise pending business by recording each incoming application in the memory, where it stays until cleared one way or another. Each day a list of cases is printed out for checking to see if special action can complete the file. The computer also uses each incoming case to refine the projection of the work load of the issue section. The projection is revised and printed weekly and shows expected work load for each day for the next six weeks and for several months thereafter as weekly totals.

Finally, the computer performs a variety of clerical functions: it creates an underwriters' and an index pending card; it prints an acknowledgment of cases received for each general agent; it creates a weekly bulletin of cases received by number, amount, and agency; it triggers the process of paying examiners for examinations completed during the previous thirty days.

MR. LOWELL M. DORN: The New York Life has used its electronic computing facilities quite extensively for mortality and morbidity studies.

For example, we prepare our contributions to the annual Society studies as part of our regularly scheduled EDP procedures. The exposures are derived from special statistical summary tape records that are updated each year. These statistical summary, or exposure, records are the same as our valuation in-force summaries, except that they have finer subdivisions of data by sex, standard or substandard, medical or nonmedical, etc. These statistical summaries also provide data for certain special studies such as mortality on term insurance, guaranteed issue policies, etc.

Another source of exposures for studies on our EDP equipment is a special detail historical file maintained on magnetic tape expressly for special mortality and impairment studies. This file, which we call our "underwriting statistics file," provides the data for our aviation, large amount, and substandard experience studies as well as many internal-use studies for specific impairments or occupations.

A seldom-used source of data for mortality studies is our actuarial detail file of in-force records maintained on tape primarily for valuation and dividend purposes. Extracting exposures from this master file is relatively

expensive, since it involves running the entire file in order to obtain the necessary records. It is therefore used only for important "one-shot" studies. An example would be our recent contribution to the double duration part of the Society's current extended term study.

MR. LEIF JOHNSON: Presently the Prudential has two computer systems producing mortality studies. The more complex 705 system annually produces data on the calendar-year basis for classifications, including issue age, duration, sex, medical, rating, regional home office, plan, amount, and agency classes.

The input is a by-product of the 705 valuation system and consists of all regular and debit ordinary policies. A seriatim exposure calculation is made considering each policy's contribution.

Mortality ratios are calculated on the latest available basic table and on Prudential Standard, which is developed from current-year experience under standard policies.

Formulas for the 1963 calendar-year study are:

$E_{[x]} = I^{i63}_{[x]} - \Sigma W \cdot T^{i63}_{[x]}$;
$E_{[x]+1} = I^{i62}_{[x]+1} - \Sigma W \cdot T^{i62}_{[x]+1}$, etc.;
$E_{[x]}$ = the age $[x]$ exposure contributed by 1963 issues;
$E_{[x]+1}$ = the age $[x]$ exposure contributed by 1962 issues;
I^{i63}_{x} = the in-force at the end of 1963 arising from 1963 issues;
$I^{i62}_{[x]+1}$ = the in-force at the end of 1963 arising from 1962 issues;
W = the time interval from the beginning of the calendar year to the time of the transaction;
T = the algebraically signed transaction, e.g., issues and reinstatements are positive, while deaths and lapses are negative. Deaths are only exposed until death; thus the resulting exposures are for forces of mortality, u_x.

By identifying all transactions as alpha or delta (after or before anniversary), the portion of the 1963 calendar-year experience applicable to the 1962–63 policy-year study can be determined. The 1962–63 policy-year study is then made up of the appropriate parts from the 1962 and 1963 calendar-year studies. Adjustments are made to expose deaths to the end of the policy anniversary, thus producing exposures associated with probabilities of death, q_x.

The 1401 Individual Card Exposure System (ICES) is more refined and flexible and was required for special studies not possible with the 705 system by reason of the latter's limited input data.

Data for the ICES consist of a set of IBM cards coded with under-

writing, issue, and status data. Underwriting and issue information is punched as part of the issue process; current status only when the cards are selected for a study. This is done by searching the 705 valuation tapes or by referring to the register files.

The computer (1) reads each input card for codes identifying the categories (starters, new entrants, withdrawals, deaths, etc.); (2) calculates the duration at which these events occur; (3) applies the exposure formulas; and (4) prints out the results. Header cards further instruct the computer to perform a policy-year or calendar-year study and how to group the results by issue age and duration.

MR. J. GORDON FLETCHER: At the Canadian Government Annuities Branch, I am completing a quinquennial mortality study using an IBM 650 which gives very neat tables of exposure and deaths with a five-year select period.

MR. RUPERT L. SUTTON: There are four major computer applications in the general area of insurance company or pension fund investments: (1) market analysis; (2) security analysis; (3) portfolio recordkeeping; and (4) portfolio selection.

Mathematical advances since World War II in the treatment of probability beliefs and their application to military and commercial decisions involving risk and uncertainty have led to a technique developed initially by Dr. H. M. Markowitz for achieving an "efficient" diversification of investments.

Computer programs now in operation accept input of this nature: (1) an analyst's judgment as to the expected return and associated risk for each of N specified investments; (2) his assessment of each investment's likely price correlation with each other investment being considered; (3) explicit constraints on the type of portfolio (e.g., legal or policy stipulations); and (4) the treatment of taxation.

The problem which the programs solve is to determine the proportions in which the total funds are best invested in N different securities in order to achieve a specified return for the whole portfolio with the minimum over-all risk.

It is important to note that computers are not supplanting the human analyst; they accept and build upon his judgments. The computer output is usually a series of portfolios, and the selection of the most suitable one for a particular set of circumstances is a matter for the analyst's judgment alone.

The Markovitz model is merely one approach to the problem; any model can only be approximate and subject to criticism.

Published work on this subject is scanty, and it is believed that much good work is not being made public. The financial implications of achieving even a slight improvement in the return on the invested assets of a life insurance or pension fund are not inconsiderable.

As an aid in investment review or in developing or validating over-all investment strategy, this is a technique which cannot be ignored.

MR. JOHN K. KITTREDGE: Over the last five years, Prudential has developed computer systems for calculation of commissions and dividends, life and health claim accounting, and premium billing and accounting, as well as a number of smaller systems for other functions, such as the preparation of group creditors' rate charts. Our systems typically process only about 95 per cent of our cases of twenty-five or more lives.

These are independent systems, but they are related, and output from one becomes input to another where information must be passed from one to another. An integrated system, with our computers, would have made the initial programming far more difficult and the required modifications as our business changes almost impossible.

We also are examining means of using the basic data on tape under the present systems to gain a better insight into our operations. We have been frustrated with our inability to obtain accurate earnings data until long after the close of a calendar year. New computer techniques of analyzing the components of earnings should give us more up-to-date data and help us to make more intelligent decisions.

Many advantages have been derived from these major systems and from smaller computer operations. Operating costs have been reduced, and we have found the new information available to us only through computer processing to be of considerable value, especially with outputs specifically designed for claim control work. Our accuracy rate has improved dramatically. The costs of making revisions in programs have been higher than anticipated.

A number of computer systems are used for administration of group pensions. The largest is a combined check-writing and valuation system for retired lives which performs nearly all the required functions. A commission calculation system and various valuation programs are in operation.

Computers are used for calculations on new pension case proposals. For in-force cases, cost estimates frequently are tailored to the individual case using FORTRAN.

Policyholders more and more are beginning to use computers for administration of group insurance and pensions.

MR. A. HENRY KUNKEMUELLER: American International Life Assurance Company of New York is installing a 1401 computer system to compile and analyze experience data on the world-wide group life and accident and health insurance underwritten by our affiliated companies in the American International Insurance Group. The system will provide timely information on experience trends in all areas of the free world and aid in the co-ordination of our world-wide group operations.

We expect the computer more rapidly to digest and consolidate data given in more than fifty currencies and to pinpoint trends and potential trouble spots in time for effective executive action.

MR. WILLIAM S. YORK: The electronic system of the Metropolitan is designed to perform the premium commission and dividend accounting function for employee benefit plans. The master file is organized into cells for each group, for each employee within the group, and for coverages applicable to each employee. Issues, including preparation of the policy or certificate, changes, and other transaction activity, are processed daily, and the policy and other visible records are produced as a by-product of this process. Billing and dividend calculations are normally performed once a year for each group. Premium payments are run against the file weekly, and the system is in a position to audit these amounts, credit commissions, and calculate appropriate adjustments to the premium, dividend, and commission calculations as required by transaction activity.

Claims are processed external to the tape system, but punched cards derived as a by-product of this process are run against the master file weekly in order to extract applicable policy data for entry into the actuarial system.

An actuarial project to produce in-force and claim statistics is currently under development.

Another system, currently in the course of installation, embraces the record-keeping aspects of the company's insurance and retirement program. The company's two major payroll systems, its home-office and field payroll systems, are both operative on electronic equipment and are in a position to feed transactions to the I&R system by tape with no human intervention. Inputs are also received via manual means from other payroll points. These are applied against a master file containing for each employee a record of his applicable insurance benefits and his annuity accumulations to date. The latter are further supported by a historical record of transaction activity and a distribution by rate. This file is tabulated once a month to produce a bill and is tabulated annually into valuation cells for entry into the punched-card valuation system.

We plan ultimately to extend the system to embrace the payment of claims, the preparation of checks to retired annuitants, and the valuation function.

For group health, weekly benefit claims are processed on a daily cycle on electronic equipment. These functions include the determination of amount payable, the establishment of appropriate audit records, the preparation of checks, and the generation of entries into the actuarial system.

The claim approver is instructed to regard each report submitted to him as an original claim without reference to prior claim history. His function is to evaluate the nature and severity of the claimant's disability, classify it into one of twenty body systems codes, and establish appropriate call-up dates for review. The punched-card report to tape is almost entirely transcribed directly from the claim form submitted by the employee. The electronic process relates this report to any prior claim history and looks up the applicable benefit limits and other contract provisions on a plan master file. The appropriate calculation is performed, and a check is produced. Weekly payments continue automatically until a return to work report is received or the applicable benefits are exhausted or until one of the preset call-up dates is reached.

The system provides for the processing of claims on an overnight cycle so that over 80 per cent of the claims are paid within twenty-four hours of receipt. The approver case load has been improved markedly, and significant improvements have been achieved in control and accuracy. The availability of certain statistical data in magnetic tape form is also expected to prove beneficial.

The system currently is about 40 per cent installed and is expected to be completed within a few months. Systems for the processing of hospitalization and surgical claims and comprehensive medical claims are now in the course of development.

MR. DAVID H. HARRIS: The Equitable is currently using EDP for group insurance in the following areas:

1. Maintenance of basic policy descriptive records;
2. Preparation of data concerning in-force amounts, claims-to-premiums ratios, and numerous calculations and tabulations of detail at the policy, premium-branch, and experience-unit levels;
3. Premium accounting, including the preparation of "skeleton" statements for self-accounting groups;
4. Premium distribution for commission purposes;
5. Payment and control (but not yet calculation) of commissions;
6. Claims summarization;

7. Calculation of dividends and reserves;
8. Rate calculations; and
9. Miscellaneous actuarial research.

Our next major steps will be to install an EDP system for the maintenance of individual life records for home-office accounting groups and to do the billing for these groups and to complete the commission part of the over-all system by installing magnetic-tape commission master files and carrying out the commission calculations by computer.

For group annuities, our present EDP operations are considerably less extensive. They include dividend calculations, with a substantial amount of support processing; certain parts of our reserve and inventory work; detailed life-by-life record maintenance on an experimental basis for two contracts; and a number of miscellaneous actuarial and administrative activities. We are about to institute a computer procedure for basic proposal calculations, and, as a more far-reaching development, we are well along in the detailed design of a comprehensive administration system dealing with both contract-level and individual life records for deferred annuity contracts.

MR. ROBERT B. SHAPLAND: I would like to outline six areas where Mutual of Omaha is using or plans on using electronics in the claim-paying and claim-statistics areas.

We pay claims on a local basis and audit or verify those claims in the home office. In this regard, we are in the process of working into a 5 per cent sample audit in place of the 100 per cent audit we did have. Through electronics, we will analyze the errors found in the sample audit to determine where corrective action must be taken in our claim-paying procedures.

We are currently in the process of hooking up each service office with our computer, using telephone-relayed information during the evenings. Through this system, in-force status information is available overnight. Eventually, we will give status information instantaneously via RAMAC, with terminals in each service office.

We are currently converting our manual claim-history records to a RAMAC file. When this is finished, claim-history information will be available to our service offices instantaneously.

We are in the planning stages of a program which will have our computer calculate claim payments. This will be done by playing our benefit-history information and policy-benefit provisions against the submitted claim.

We are also in the planning stages of putting our manual policyholder

alphabetic index file on RAMAC. This file is used to find all the policies held by each policyholder when underwriting and when paying claims.

We are currently keeping a running tape which summarizes all the payments made under each claim. This tape is played against our exposures and against our expected morbidity factors in deriving "actual to expected" morbidity ratios. These ratios are developed by sex, age, class, policy year, calendar year, type of benefit, and state of residence. Ratios are developed for frequency, average size, or duration of claim and the product or claim cost. While these ratios are currently calculated on broad classes of business only, we may eventually calculate them separately for each policy form.

MR. DORN: We have been maintaining claims data for individual health insurance on magnetic tape for several years. Our morbidity studies, which we have programmed for various health insurance coverages, are based on our historical file of health insurance claims which is maintained on magnetic tape in policy-number and claim-number sequence. This claim file is used primarily for these statistical studies but also for developing claim-reserve totals for the annual statement and data for Schedule H of the annual statement. We also use this electronic data for developing internal fund accounts by type of benefit and year of issue, as a guide to surplus development and dividend scales for individual health insurance contracts. Although we do not pay individual health insurance claims by use of the computer, we do have a program that applies various consistency checks to claim payment records. We have found this very helpful in detecting clerical errors. We are also planning to use our claims data to seek to identify any areas of abuse and to ascertain relative costs in various parts of the country.

MR. W. GLENN McCORMICK: One of the major problems in any EDPM system of morbidity studies and maintenance of claim data is obtaining an input at minimum inconvenience which can be reconciled with ledger accounts.

Exposure at the Prudential is derived from our basic valuation-statistical in-force file as a by-product of the dividend calculation at the end of June of each year. The IBM 1401 is used to provide information on tape for the dividend liability calculation as well as exposure for loss ratios and A/E claim studies.

At the time a policy is issued, among the subsidiary records produced is a card to be retained in the field office containing policy details. Whenever a claim is paid from the field office, this card is used to provide the necessary policy particulars for the payment and for the records sent to the

home office. Each day, the check stubs, the ledger accounts, and claim-accounting card are proved. Each month, the claims are checked for plausibility by 1401, and total payments agree with the ledger. By preparing our claim data on a daily cycle, intercompany contributions or any other specialized information is obtainable at minimum inconvenience.

At the same time, we prepare totals by agency office within state, and, hence, by state for the state exhibits. Amounts by policy type and year of incurral are also tabulated for use in preparing the policy experience exhibit and Schedule O.

At the year-end, the claim detail cards are summarized by 1401 and compared with the dividend tape to give loss ratios by issuing agency office. If necessary, loss ratios by individual agent can be obtained. These results can be used to shape our underwriting policy by area.

In the early part of each year, we study claims for the second previous year. In connection with this, only the first year of disability on income claims is studied. Hospital claims are also assumed closed. Major medical has a suitable claim liability adjustment added.

At the present time a program for obtaining A/E ratios by computer has just been completed.

MR. WILLIAM T. TOZER: We at American Republic are paying over one-half million individual health insurance policy claims per year, using a computer. Approximately 90 per cent are hospitalization claims.

When a claim is received, a policy-status sheet providing the following is secured from our Electronic Data-processing Department: (*a*) issue date; (*b*) coverage purchased; (*c*) premium paid-to-date; and (*d*) any lapse and reinstatement dates.

If the claim examiner in the Claim Department has sufficient information to approve the claim, he completes a slant-mark sheet, on which he marks: (*a*) date of disability; (*b*) number of days in hospital; (*c*) number of doctor calls at the office, home, and hospital; and (*d*) whether maximum miscellaneous benefits are payable. If not, how much should be paid.

This sheet is then passed through an IBM 1232 to produce an input card for the computer.

Next, the claim examiner states, on a separate sheet, if there are any assignments and for how much, as well as how much surgical benefit should be paid. This information is key-punched into an input card for the computer.

With these two cards the computer then (*a*) calculates the benefits to be paid; (*b*) distributes these benefits to the various assignments and the insured; (*c*) prints the claim drafts and writes letters listing these benefits

for each assignment and the insured; (*d*) generates an outstanding draft tape; and (*e*) generates a claim-history tape.

This system has the advantages of (*a*) eliminating routine calculations for the expensive claim examiner; (*b*) shortening the training period of new claim examiners by eliminating the need to learn all the benefits of all the policies ever issued by the company; (*c*) being more accurate in the calculation of benefits; (*d*) providing faster service to the policyholders; and (*e*) being more economical than the prior system.

This job has been in operation since September, 1963. It requires an IBM 1401 with 8K memory and four tape drives.

MR. WILFRED A. KRAEGEL: The scope of "aids to the sales force" from the computer is much broader than the automatic preparation of planned insurance programs if we define such an aid as anything which helps the agent to write new business or to keep it in force. The agent is aided whenever the home office makes an improvement in any of the following activities:

1. Design of a contract to better meet an individual's need for personal financial security;
2. Speed of underwriting and issue;
3. Accurate up-to-date status of existing policies;
4. Specific sales aids, such as:
   a) A proposal for new insurance;
   b) Automatic preparation of planned insurance programs;
5. Home-office service of a quality (in speed, clarity, and accuracy) which pleases the policyowner rather than antagonizing him;
6. Specific conservation aids, such as:
   a) Premium-reminder notices or late-payment offers;
   b) Increase in cash value shown on premium notice to stress investment aspect;
   c) Warning on premium notice if there is insufficient value to charge premium as a loan;
   d) Information to the field office showing what will happen if the premium is not paid, including specific nonforfeiture values;
   e) Making it easier for the policyowner to pay premiums through preauthorized checks, premium payment accounts, etc.; and
   f) A notice of lapse, which includes a form with specific data for reinstatement.

The Northwestern Mutual Life uses its four computers to try for most of these objectives. We do not yet use our computers for underwriting or for planned insurance programs, but we can point to specific improvements in each of the other areas just mentioned.

A more extensive discussion of this subject is given in the *Proceedings* of the 1963 LOMA Conference. Perhaps it would be of interest, though, to mention the two computer-based improvements which have received the most enthusiastic and widespread reaction from our agents. The first of these is the individual agent's file of policy service cards. He receives a new card each time anything happens to the policy (except for billing), giving cash and loan values as of the paid-to-date, dividend and loan account balances, and the customary variety of data which define policy status.

The other is our insurance service account, which provides a convenient means for combining premium and loan payments for several policies into one account. These two most popular results of our computer system were not originally designed as sales or conservation aids. Yet they provide the agent with information and the policyowner with convenience which make the next selling job a much easier one.

MR. RALPH E. TRABER: I include in this topic aids in the management of the sales force as well as aids to the agent. At Equitable of New York, our activity in the area of direct sales aids to the agent has been moderate. We have a program of ratebook preparation as well as various other books—dividend illustrations, pension trust, and AHO ratebooks as well as split-dollar illustrations. We currently are preparing a system to give personalized split-dollar illustrations on a daily schedule.

Our security-review program sends out to agents cards that serve as a basis of information for a service call. Also, in the course of normal processing, we watch for and notify the agent in advance of forthcoming dates of conversion, maturity, etc.

In the course of issuing a policy by EDP, a policy record card is prepared for the agent, and the policy itself is another sales aid, while another intangible aid which is a by-product of our issue system is a personalized welcome letter to new policyholders from our board chairman.

With group insurance we have programs to produce hypothetical dividend illustrations for use in the sale of new groups or extensions to existing groups. For group annuities, a system handles the benefit calculations for each life for certain classes of proposals.

As to management of the agency force, we have an EDP commission system with a combined commission statement for ordinary and group. Another system keeps track of the production and qualifications of financed agents, while a major new system is under development to analyze agents' production results by district and agency manager and compute those elements of managerial compensation that depend on these results.

A major system is devoted to sales management information at the agent, district manager, agency manager, and field division levels for all types of individual business as well as for special major markets. We also are studying a system to prepare lapse reports by individual agents, and we are developing a system designed to assist in retaining agents by sending out a statement of the approximate arithmetical sum of future commissions on ordinary business already sold by the agent.

MR. DORN: We began using our electronic equipment for insurance programming in July of this year, when we introduced an electronic service known as "Nyl-a-Tronic." This service prepares insurance programs for prospects, illustrating how present and new coverage can be used to meet required family cash and income needs if the prospect dies and also his retirement needs if he lives to age 65. There is a charge to the field underwriter of $1.00 per case. The computer runs are currently made twice weekly, and so far more than 3,400 cases have been processed. The average size of policies sold in connection with Nyl-a-Tronic is running close to $25,000.

Since a number of companies are offering this type of service, I would like to point out a few areas which we may be handling a little differently from most companies.

1. *Income needs of family.*—In order to provide the utmost in flexibility, up to six different amounts of income to the family, in the event of the prospect's death, may be specified. The periods during which these amounts are payable can be any selected by the agent and prospect. Thus it is not necessary to tie in these periods with social security, that is, the "dependency" and "black-out" periods.

2. *Present insurance.*—We take into account the income power of present insurance by asking for settlement option information on each policy already covering the prospect. The form of this information varies with the type of coverage, that is, NSLI, individual permanent and level term plans, group, family income, and mortgage protection term coverage. If settlement option information is not provided, the electronic program uses factors based on conservative assumptions. We also ask for cash value information on present insurance so that the retirement income available can be calculated by the computer.

In applying present insurance, the electronic program compares the settlement option factors of the policies among themselves and also with the current New York Life factors. It then follows certain rules intended to get the most "mileage" out of present coverage. We plan to experiment with operations research techniques to improve further the use of present

insurance and minimize the amount of new insurance required for a particular program.

3. *Retirement needs.*—One of the plans shown in the computer output is an "all-purpose" plan, that is, it will provide the required cash and income needs to the family and also the required retirement needs of the prospect. This is accomplished by using a combination of plans such that the cash value is sufficient to provide the balance of retirement income after social security, present insurance, company pension, etc., have been taken into account.

4. *Variety of plans.*—In addition to the "all-purpose" plan just described, up to three additional plans are usually prepared by the computer, in order to give the agent and prospect flexibility in working out a program. One of these provides the full cash and income needs of the family but not necessarily the retirement needs. The other two are "limited" plans, in that they provide the requested family income only during limited periods. These periods are, first, until the wife's age 62 and, second, until the youngest child reaches age 18.

Another electronic service to the field, introduced late in September, is the preparation of personalized sales illustrations, showing dividend illustrations and policy values for a specific plan, age, sex, and amount of insurance or amount of premium. The agent can request up to six different illustrations on the same life among nine plans of insurance and six types of illustrations. The charge to the agent for this service is $0.25 for the first illustration and $0.10 for each additional one on the same life. Currently, illustrations are being prepared on over nine hundred prospects per week, with an average of two illustrations requested per prospect.

MR. ALBERT E. REAVILLE, JR.: One use of the computer system at Connecticut Mutual is the preparation of individual and composite insurance illustrations. The latter show cumulative figures for a group of lives.

Six formats are offered: ledger statements with dividends applied or dividend additions or showing both the applied and additions options and the retirement-income figures; split-dollar illustrations, with dividends applied or used to buy one-year term, with the balance accumulated or alternatively with the balance applied. Plans of insurance are: whole life, graded premium life, and life paid-up at 65.

An agent can request an illustration by mail, using a post-card request form or by telephone. The time service is three days with good mail service.

MR. JAMES J. HALLORAN: The Prudential is using computers to prepare directly two aids for our agents, an electronics report and individualized ledger-type illustrations.

The electronics report is a fairly brief statement of the annual net cost of insurance, where such cost is defined as annualized premium less current dividend less increase in cash value. Each of these items is shown separately as is the identifying data. This report was prepared initially for regular ordinary premium-paying policies on the fifth and later policy anniversaries for most permanent plans. The servicing agent determines whether or not to deliver this report. It is especially effective in minimizing lapsation at the duration the premium increases on modified premium plans.

Six ledger-type illustrations are available: key-man, ledger, and split-dollar statements using dividends to provide one-year term insurance, or not, and using the remainder, if any, either to reduce premiums or to provide paid-up additions. These illustrations show pertinent data annually for twenty years and certain results at 65. This service is available on basic permanent plans for amounts of insurance of $20,000 or more only. "Next"-day service is available within the office; that is, an illustration based on data received prior to 10:30 A.M. one day will be mailed early the next day. Calculations are currently being done on an IBM 650 and printed on an IBM 1403. If well received, the current program will be converted to the IBM 1401/1311.

MR. A. DOUGLAS MURCH: The desire to move to new model computer equipment is usually motivated by (1) the lack of capacity in current equipment to handle desired improvements in systems or (2) the promise of lower unit costs with the new equipment.

Against these advantages must be weighed the disadvantages of reprogramming existing jobs for the new equipment, and exchanging, for a very small monetary return, computer equipment that has been purchased. These disadvantages have made replacement of equipment less frequent than it otherwise would have been.

However, there are forces at work that may ease these disadvantages in the future. Computer manufacturers are doing a better job of making new equipment "program-compatible" with old equipment. This, plus an anticipated increase in the use of the COBOL programming language, ought to make the reprogramming problem less severe in the future.

The trend toward reduced rental charges for equipment use beyond the first shift may make purchase of equipment less frequent in the future.

The purchase versus rental break-even points for some of the new generation equipment are one to two years longer than for current equipment, assuming a three-shift usage. These factors may combine to make future equipment replacements less difficult than they have been in the past.

MR. HARRIS: We recently completed a conversion from three identical "first-generation" machines to two identical "second-generation" compatible successors. The most important factors in this decision were (1) the considerable increase in over-all power from the old machines to the new; (2) the ability to run existing programs without change and without substantial loss of the new machines' inherent efficiency; and (3) savings in operator costs by comparison to adding additional "first-generation" units.

We have not adopted a programming language such as COBOL that might be expected to facilitate future conversions, although COBOL is currently under study again. In the past, we were discouraged by four aspects of COBOL: (1) the inefficiencies, in terms both of memory use and of object-program running time, of some COBOL compilers; (2) the "dialect" problems; (3) indications that COBOL has not done as much to help in business EDP programming as, say, FORTRAN has done to help in scientific programming; and (4) a feeling that we are going to want to revise systems, and hence change basic programming logic, in order to take advantage of random-access files, multiple on-line terminals, and other new developments that will have an important influence in the next major computer-selection decisions. Whether these arguments will be strengthened or weakened by the current restudy, I do not know.

We have used one "compatible language"—our own "Equitable Life Interpreter." ELI was first implemented for a punched-card computer and is now in use in its third machine environment with several of the original source programs still in use.

MR. MANUEL R. CUETO: Some major considerations bearing on problems of replacement of existing computers with new-generation computers are (1) present computer facilities are at maximum capacities; (2) present equipment cannot handle the contemplated new advanced system of operations; (3) cost/benefit comparisons of proposed new computer-based systems with existing systems indicate the economy of a switch in equipment; and (4) software compatibility obtained by adoption of common procedure-oriented languages.

Cost and savings comparisons may show that, from the viewpoint of over-all economy of operation, a replacement or expansion should be made irrespective of when the break-even point occurs.

At New York Life, anticipated cost savings have been exceeded.

While the replacement of equipment will involve the preparation of new forms, manuals, practice books, and educational sessions in connection with retraining of personnel, revision of programs and of operating procedures, another major problem is the undisturbed continuation of current operations, including maintenance of current programs, until swing-over is completed.

MR. MURCH: Daily runs of master record files not only are feasible but also are necessary if the electronic data-processing system is to furnish up-to-date information for case-work operations.

Many companies are, however, coming to realize that the ultimate goal is to have the electronic data-processing system furnish immediate responses to inquiries of many different types whether these inquiries enter the system from the home office or from a field office. To do this, both master-record data and programs must be placed in electronic storage attached to the computer. Data communications facilities and terminal equipment must also be provided to link field offices with the home office. Several companies have plans under development that are aimed at achieving some aspects of such a system, though in most cases it will be many years before the goal is fully achieved.

While the economics of electronic storage of policy files and data communications using present-day equipment is open to considerable question, the cost has been coming down rapidly. As the cost continues to drop, we can expect to see increased use of these features in the insurance industry.

MR. JOHN J. FINELLI: Master-record files are being run daily in several large companies, and in the very large ones where this is not yet the case preparations are being made to establish daily runs.

Metropolitan's experience with semimonthly updating of about six and a half million policies indicates that daily runs would be practical—as does our Pacific Coast office, which is now updating daily about 600,000 policies.

Our estimates indicate that a daily scan of our entire file of forty-two million policies can be made in eight to ten computer hours.

The mode of operation will require scanning daily to take off policy data for current transactions. In the process, an updated item will be developed and tacked on to the end of the master file. At the end of a week the master file will be copied and recorded with consolidated policy items.

We expect to install one consolidated tape file for life policies on a premium-notice basis, one for corresponding health policies, but two files

serving separate but related functions on "Account" (i.e., "Debit") business—all to be updated on a daily cycle.

Turning now to real-time and random-access devices, we have two points to make. The first one is that whatever economic promise they hold does not derive from their ability to give policyholders more prompt service. A "while-you-wait" service to policyholders has and will probably continue to cost more than the one- or two-day service standard now in effect, even in the electronic age. This, however, does not mean that we will not do it. It could well be that more prompt service than is now the case will become the rule in our industry—and, if it does, we as well as others will undoubtedly adopt it even if at an increase in cost.

The second point to be made is that real-time systems may have a significant economic value in the form of simpler and less costly operating systems. It does not seem unreasonable to expect that the cost of random-access devices will be reduced to the point where it will be more economical to update and process on a random basis rather than through daily serial scanning of tape files. When that occurs, it will probably also develop that we will need even fewer visual records than those we are now planning to keep—and we may well move into a mode of operation under which random-access devices will maintain the utility records with tape or its equivalent assuming the role of the keeper of reference records, reducing the reliance on paper files and books of registry almost to the vanishing point.

Plausible reasoning leads one to the conclusion that "real-time" access does hold economic promise—but the promise stems from the possibility of making highly efficient electronic systems even more efficient in the future. At present, however, real-time systems seem to be too costly. Whatever promise does exist is still some years away.

MR. HARRY D. GARBER: We believe at Equitable that real-time access holds economic promise. This is because of our administrative environment. Our sales offices have no administration functions; we have a completely separate set of eighty field offices that do our administrative work. These offices maintain a virtually full set of records, and policyholders deal direct with them, receiving very prompt service.

The field offices cannot bill premiums, etc., so that we have a duplicate set of records in home office. In fact, our EDP has been built up to have separate records for premium-billing, valuation and commission, and dividend calculation. We have records in the field being maintained manually; many records in home office are maintained—some on tape, some by

punched card, and a few manually. This setup gives local service but requires a good deal of duplication of record-keeping.

If we consolidate our records into a single record, put them on a random-access file, consolidate all the information in the home and field offices, and make the other necessary computer connections, we can give the field offices access to home-office records. Rather than keep their own records, they can send a message via the terminal set and get the necessary information. If, on the basis of this, the policyholder wants to do something, this can be done by sending a message in over these lines, and the response will come back.

We believe this will eliminate jobs in both the field and the home office, and these jobs, when evaluated at their salaries, will produce an expense saving about double the equipment cost.

MR. TOZER: American Republic has a master file of over one million policies. These are individual hospital policies, and we find it necessary to work our master file daily for two reasons.

First, for claim purposes. Since hospital claims have a high frequency and require prompt payment, we are not permitted to provide poor service in this area.

Second, over 50 per cent of our business is billed monthly. Consequently, we are billing soon after the previous notice was due and must have the most up-to-date records available at the time of billing.

We feel that the new, more economical random-access equipment is a godsend for two reasons: (*a*) that a large percentage of the file that has no activity will not have to be handled and that (*b*) such items as status information may be secured on a "real-time" basis (we feel that this alone will shorten our claim-paying time today). We are investigating the use of an audio-response unit because (*a*) it makes the economical telephone an information source for limited information; (*b*) it is relatively inexpensive; and (*c*) it requires very little computer time.

I believe that "real time" will, in reality, be a mixture. By this I mean that many jobs will continue to be batched. For example, many companies balance their premium income before it goes to the computer. This creates a natural batch. I do not feel that this is necessarily bad.

However, the big plus, I feel, is that information can be supplied to such departments as policyholder service and claims instantly as needed. True, some of the data may be twenty-four hours old, but, once an employee opens a file, he can complete the file in one sitting.

I definitely feel that the more economical random-access devices have made "real-time" information systems practical for larger companies.

MR. ROBERT G. ESPIE: At the Aetna Life Companies we have always had, in addition to the requirements of cost distribution by line of business, common to all life companies, the further requirement of careful allocation between our life company and our affiliated fire and casualty company. The problem of allocation of EDP costs was therefore not exactly new.

Our allocations of developmental costs, programming costs, and operating costs are all based on a basic job-number system. Each separate project is treated as a unit and separately identified by job number. Each job number bears its own allocation to a particular line of business in a particular company or to a group of lines. Most of our projects are fairly easy to identify by line.

As a project passes through the various stages from initial conception to final operating stage, all time spent on it by systems analysts, programmers, and machine operators is recorded to that number, including the amount of time actually used on the machines for testing and for operations as an ongoing completed project.

In the developmental stage the amount of cost so recorded accounts for a very substantial portion of the total cost of the EDP development department, but naturally it does not account for 100 per cent. We may have in a category unidentifiable by job number our costs for schooling analysts and programmers, our study of generalized programming techniques, our research into machine capabilities, and, of course, the supervisory overheads of the department. Since our readily identifiable costs form a large part of the total, we allocate the not readily identifiable in the same proportion as the readily identifiable, a commonly accepted basis for the allocation of overhead.

For input preparation costs we rely heavily on the number of records prepared and processed, again identified to job number. Input data-preparation allocation further involves assigning weights to relative complexities of key-punching and verifying, but this does not pose enormous difficulties for us, since we have for many years assigned such weights to card preparation for the purposes of our incentive bonus keypunching system. Again, the recorded data account for a large percentage of the total, and the overhead follows the recorded.

For EDP machine operations we keep a record on each machine of the actual time by job number and thus have a means for allocating the rental, the machine operator's time, and the overhead. We do not dif-

ferentiate between prime shift and overtime shifts, so that each job shares equally in our total mix of first shift and overtime costs, leaving the scheduling administrator free to schedule whichever shift is most convenient and economical for the companies as a whole. Although we include test time by job number, we pro-rate rerun time on account of machine failure, preventive maintenance time, and gaps due to scheduling flaws, all as a part of overhead.

For purchased configurations, as distinct from leased, we compute a time charge per year, considering interest on the investment, maintenance, insurance, and depreciation on a realistic schedule usually involving a shorter write-off than is allowed for federal tax purposes. The cost so derived is distributed analogously to rental costs.

With integrated systems the former ability to allocate by functions is seriously impaired. In the past, the policy file used for valuation would be charged as part of the cost of valuation and the billing file as part of the cost of billing. With a common file serving both purposes, and with a compromised file organization that may not be ideally suited to any one of the functions served, the functional allocation problem becomes confused.

Our thinking is that the problem may be resolved, or avoided if you prefer, by rethinking the definition of functions so that, for example, we now have the function of valuation work in the actuarial department, billing work in the accounting department, and computer work in the computer services department. In effect this says that it may be futile to try to break down the computer work into functional steps which have been outmoded by the computer.

I think that the functional allocation of an integrated computer operation may very well have to begin with a fundamental reappraisal of what we mean by function and what we want the cost study to achieve. It may end by considering the integrated operation to be a separate function in its own right.

MR. MAURICE V. DONOVAN: Metropolitan has a team type of organization for development of the respective electronic projects; for example, life insurance billing, group health claims, personal health premium accounting, and so on. There is also a computer log for production work and for machine time used in program translation and testing. Consistent with traditional principles, expense allocations to lines of business are based on clerical time and machine time, as indicated by the clerical organization and machine log, respectively, and further functional allocations are made according to the broad purpose of the development or the broad functions of the processing.

It is convenient to conform to the present expense allocation system in charging initial costs on the basis of clerical and machine time used in development and installation. However, there is good reason for questioning that the practice is completely realistic and equitable. For example, there is little doubt that, after programmers have gained experience and can "borrow" the logic of earlier systems, development costs are lower. It also seems reasonable that lines of business not yet installed should bear some of the cost of the earlier installations. This is all the more evident when equipment changes cause re-engineering of the earlier projects, thus increasing the development costs again.

There also may be inconsistencies and rather arbitrary interpretations involved in the allocation of the operating costs of installed projects. To cite a few examples: parallel processing where several programs are running simultaneously on a single machine, the use of a file for several functional purposes, multipurpose machine runs (an advantage of a large computer system)—each of these operations raises a question of allocation of what might be called a joint cost; that is, the cost of hurling the stone that knocks over several birds. To a certain extent, the joint-cost allocation problem has always been with us, but it is now present in a more disturbing form and to a greater degree than before.

In the past, the major joint-cost problem involved the management area, growing more difficult as one went up toward the top of the organization. We always had joint costs related to multipurpose manual and punched-card files, and some of our specialized files have been multipurpose so far as our functional accounting is concerned. However, such joint costs represented only a minor proportion of the total expenses. Most of the expenses could be readily allocated, and we could then spread the joint expenses as a burden or overhead or in some other arbitrary way on transaction costs or other functional subdivisions which were readily distinguishable for cost-accounting purposes.

However, the advent of electronic development processing has changed the picture considerably, and joint costs in this special sense soon may be the major portion of the total expenses. An extremely refined analysis of machine time and, for that matter, of the time of the operating people would seem to be required in order to provide current expense analysis detail. It may not be practical to do this. In addition, conflicting philosophies can and likely will be developed as to how unused machine time should be allocated, as to how the equipment might otherwise be used, etc., and it will be important to guard against the temptation to spend an undue amount of time on refinements of allocation at the price of increased overhead expense.

Rather than attempt to refine the present system of cost accounting, perhaps we should develop a new approach that directly recognizes the impact of the mechanization of our clerical operations. Above all, we should strive for a system that is simple, flexible, and economical as well as representative.

MR. WILLIAM L. BARBER: Problems have arisen for insurance department examiners because of EDP systems. One problem is that state examiners have had very little experience with EDP technology, programming, system design, internal controls, or machine logic. This problem is magnified by the fact that some insurers are "systems-oriented" instead of being "single operations-oriented."

Another problem related in some ways to the first has been the fact that some of the earlier EDP systems were not designed with department examinations in mind. Some of these systems were so developed through error and oversight, while others were created with the hope that the examiners would make use of "models," "test decks," and "selected samples."

Still another problem is the very many different types of installations, configurations of equipment, and different systems of operations, all tailored to meet the specific requirements of each insurer. Thus the examiners in some states are faced with the task of giving individual considerations to a number of different systems and configurations.

This problem suggests to me the advantages that might accrue by the adoption of packaged programs such as the 62 C.F.O. When such generalized programs become available to larger companies, would not it be easier for the examiners to conduct examinations if many companies were using the same "total systems" procedures? It seems to me that examiners could be educated at the hardware manufacturers' schools which were being conducted for users of the packaged programs. Why would this not prove to be economical for both the insurers and the insurance departments?

As you know, the *NAIC Examiners Handbook* now contains some "Procedural Guide Lines for the Examination of Accounts and Records Compiled by Electronic Data-processing Systems." Just what additional problems will result as these guide lines are pursued remain to be seen. There are some rather general terms used which may become very subjective in application, but the guide lines do provide for a preliminary meeting between home state examiners and officials of the insurer for the purpose of arranging that appropriate data be available for examination. This meet-

ing could accomplish a great deal of good so long as we do not end up with the paradoxical situation of the examined educating the examiner.

In conclusion, I think it should be mentioned that possibly the examiners are faced with future problems as we go farther into such sophisticated areas of EDP as "random access," "real time," "teleprocessing," and "associative memory."

MR. CUETO: Recognizing the problems inherent in the use of EDP systems, the National Association of Insurance Commissioners, in June, 1963, adopted "Procedural Guide Lines for Examination of Accounts and Records Compiled by Electronic Data-processing Systems," which are incorporated as part of the *NAIC Examiners Handbook*. These guide lines were prepared by the Industry Advisory Committee representing all branches of insurance, working in close collaboration with the NAIC subcommittee on automation.

The practical effects of the mechanization of record-keeping, operations, and accounting on examination procedures have been to add to the complexity of the examining function. At the same time, when the guide lines were prepared, few state examiners, if any, were trained in the use of computers to do their examination work. Hence, one of the major purposes of the principles contained in the guide lines was to place the examining authorities in the same position as they occupied prior to the advent of EDP with respect to examination of records. While this may appear to be a backward and possibly costly step, it nevertheless helped to solve, for the present, some of the problems facing the examiners making an examination of companies with EDP systems.

The Industry Advisory Committee was well aware of this fact and, accordingly, included in its report to the NAIC a paragraph with respect to future considerations, which was, of course, not included in the guide lines. However, it may be appropriate at this time to recite this paragraph.

> The Industry Advisory Committee strongly recommends that the next natural development should be for the examiners to make use of "models" or "test decks" or "selected samples" of data to check both electronic programs and procedures according to examination requirements. Such requirements might include a review of consistency checks of input data, editing routines and other techniques. This, of course, is a more advanced approach to the problem of audit and control but one which will eventually emerge as knowledge increases in this field.

In this connection, it is encouraging to note that the New York Insurance Department, and one or two others as of the present time, have selected members of their field examining staffs to attend courses and re-

ceive training in the use of electronic computers. It is hoped that this education and training will eventually equip examiners to go "through the computer" in their examination function, instead of "around the computer" as at present, with mutual advantages to both the examiners and the insurance companies.

MR. HERBERT L. FEAY: I have had some experience that indicates the kind of problems an examiner or auditor can have with EDP systems. I worked in the New York State Insurance Department for a considerable period of time, and I am now employed by Joseph Froggatt & Co., Inc., a private auditing firm. My experience is primarily with actuarial liabilities of life insurance companies.

In general, the verification of the reserve liabilities can be separated into two parts—a verification of the reserve calculations and a verification of the basic valuation information. A state insurance department or a private auditing firm should not certify as to the correctness of a company's reserves for any classification of benefits for which a proper verification cannot be made in a reasonable amount of time for both the calculations and for the valuation details for the benefits in force. If a proper verification cannot be made in the time available, it is better that the report of the examiner or auditor states that the company's figures have not been verified but have been accepted for the purposes of the report.

The verification of the reserve calculations includes checking reserve factors, multiplications, additions, and summaries. The final summary gives the totals required by schedules in the annual statement. The EDP system must be capable of producing listings that will permit this checking to be completed satisfactorily. This will usually require group totals by plan, year, and age at issue to conform to the normal pattern of published reserve tables. For example, if the machine system gives totals by plan and year of issue without regard to age for company purposes, a program must be available that will give subtotals by age for a representative selection of plans and years upon an examiner's request.

Some EDP systems have factor tapes, and other systems calculate the factors using basic commutation functions and formulas. The EDP system must be able to produce these factors in a standard form for comparison with tables previously verified to the satisfaction of the examiner. One problem involves special plans or special reserve standards for which published tables of factors are not available. One procedure for such plans and standards is to have the EDP system provide tables of these special factors before the valuation date. This should be done sufficiently in advance so as to allow for the time needed to have the factors test-checked before

the examination or audit is completed. This verification can become complicated for some plans and benefits. The factors for the additional reserves for noncancelable accident and health insurance can be in this category of factors that are difficult to verify.

In verifying the basic valuation information, an examiner must determine that all contracts have been included in the proper classification and that no contract that should be included has been left out of the valuation.

Before EDP, the companies maintained separate premium-card and valuation-card files. A reconcilation of these two files for premium-paying policies has many times been considered proof that the valuation information was correct. Now that one magnetic-tape system has replaced these two files, the examiner does not have a valuation file and a premium file to compare. If the audited premium-payment records for current payments provide sufficient proof of the accuracy of valuation data, the tape audited for premium payments could be accepted for valuation information without further checking.

I do not accept this as correct. In fact, it seems to me that the procedure before EDP of determining that the valuation includes all contracts for which premiums have been currently paid is only a partial check based on two records maintained by the company. I believe that a cross-check to and from the application files is a necessary procedure. This is certainly true of paid-up benefits not included in the current premium file and is necessary for positive verification of valuation information for premium-paying policies. The information from the application files should be secured from the basic papers in the files and not from what the company has entered on a descriptive page for the file.

In verifying the basic valuation information included in an EDP system, I select a representative number of valuation totals included in the company's valuation schedules and request that the electronic tape be run to supply in printed form the valuation information for each contract in the grouping. This information is then test-checked to the application files. I then make a random selection of application files and request that the information for those policies be printed out from the tape. The information printed out is compared to the application files.

I wonder if an auditor should endeavor by correspondence to verify insurance policy information directly with policyholders. Direct verification with depositors is part of the examining procedure for a bank. Direct verification for insurance policies is sometimes made for premium payments and for policy loans. Additional direct verification of plan, date of birth, and amount of insurance should not be difficult.

My comments so far have been primarily for ordinary individual life

insurance. For weekly premium and monthly premium debit insurance, the EDP has made easier a satisfactory check of basic information. The complete information for the debit insurance can be kept on the tapes at the home office and not be divided among records at the home office and the branch offices and in the hands of agents. Testing, similar to that outlined for ordinary insurance, can now satisfactorily be made for debit policies under these conditions.

The EDP system has also simplified the verification task for supplementary disability and accidental death benefits, substandard risks, dividend additions, and other special items. Before EDP, the reserves for these items were usually determined by approximate methods involving large groupings and average factors. The accuracy of the approximate methods and of average factors had to be verified at reasonable intervals, and the examiner had to determine that the results were acceptable. Checking the accuracy of the benefit totals for the large groupings was difficult because of the large number of policies included in each grouping and because punched cards did not always have complete information. With EDP, all benefits of each policy are valued in the same basic groupings. The information for all liabilities for each policy in a grouping can be verified at the same time.

EDP has eliminated comparisons of premium cards and valuation cards (a limited check at best) and has made it necessary to do more basic verification to original sources of information. This appeals to me as an improvement. Auditors and examiners must learn how to work with these computers. Just as accountants of years gone by gave up hand addition and multiplication for adding- and calculating-machine results, accountants today must give up the punched-card file for the magnetic tape. The examiners and the auditors must learn to live with EDP and to take advantage of the possibilities of electronic computer systems.

Operations Research

A. In what types of problems relating to life and health insurance has it been found helpful to use
   i. Factor analysis;
   ii. Discriminant analysis;
   iii. Decision theory;
   iv. Monte Carlo methods;
   v. Queuing theory;
   vi. Linear programming;
   vii. Game theory;
   viii. Information theory?

   To what extent have electronic computers proved useful in these analyses? Should the Society take a more active part in encouraging the study of these subjects?

B. Have operations research methods been found of value in such areas as
   i. Estimation of the probability distribution of total claims for an insurance group for use in the determining of reinsurance premiums or in helping management reach a rational decision on some other risk question;
   ii. Financial analysis, such as the evaluation of future profits on new or existing premium rates or plans of insurance;
   iii. Management problems related to expense (cost-value relationships, point of diminishing returns, etc.);
   iv. Selection of investment portfolio;
   v. Predicting agency development costs and returns;
   vi. Work-flow and "backlog" control;
   vii. Determining effect of procedural changes, e.g., testing proposed processing cycles in designing consolidated policy transaction and reporting systems?

MR. JAMES T. BYRNE: Several applications of the queuing or waiting-line theory have been made at the Metropolitan Life. These studies have been directed toward both home-office and district-office procedures.

The analytic approach to queuing theory becomes very complicated when applied to clerical work-flow systems. On the other hand, with a high-speed computer available, simulation or Monte Carlo methods may be applied to problems of this type with almost unlimited flexibility. A system involving dozens of parameters can be represented by a model. The values of the parameters can be modified singly or in combination and the resulting effect determined very rapidly.

Rather than experiment with an operating system which one hopes is the optimum compromise between speed of service and expense, one can simulate the effect on the system of contemplated changes. Specific ex-

amples of the application of this technique are in connection with the number of "windows" necessary in a district office, the staffing of the home-office medical dispensary, and a large-volume home-office policyholder service function.

The statistical technique known as discriminatory analysis was applied to a problem with underwriting overtones. The use of this technique provides a rule-of-thumb method of assigning individuals or items to either of two or more categories. The rule-of-thumb provided by this matrix algebra technique minimizes the probability of misallocation. A particular example of the use of this technique required the inversion of a 34×34 matrix—a task which could not be performed without the use of a computer.

In addition to its use in underwriting problems, we visualize the possible use of discriminatory analysis in such areas as the selection of field and home-office personnel, including actuarial trainees.

The factor analysis technique—another highly sophisticated statistical tool—made it possible to simplify, by 75 per cent, the complexity of a performance report used for evaluating home-office middle-management personnel.

MR. NATHAN F. JONES: Linear programming is a technique for maximizing a function (normally linear and usually of many variables or "activities") subject to a number of linear "constraints" on these "activities." These constraints may be equations or inequalities.

The restriction to linear functions is limiting. Nevertheless, it can be said that linear programming has made possible the overwhelming majority of the savings with which industrial operations research has been credited, particularly in a few type problems. Such problems common in manufacturing industries are not important in insurance. Surprisingly enough, various linear programming applications have from time to time emerged in our work. For example, the inequality

$$\alpha_j P - \Sigma \beta_{ij} D_i - \gamma_j \gtrless M_j ,$$

where P equals annual premiums, γ equals those elements not dependent on the size of premium or dividend, and D equals various durational dividends, can express many bounds an actuary may want to impose on asset shares. Or the same form can express something so mundane as a traditional "net cost" or "net outlay" criterion to satisfy the agency department. Pick one of those left-hand sides to maximize or minimize subject to the others as constraints, and we have a linear program. Normally, there will be some conditions relating the D's (that they be mono-

tonic nondecreasing during the premium-paying period, at least, and probably more), and the whole may be carried for not more than, for example, twenty years. So, with computers, the method is not impractical.

In fact, it has value even if the actuary refuses to select his premium by optimizing any one linear function and merely wants to delimit the feasible "volume."

In game theory, on the other hand, practice—industrial practice, certainly—has lagged so far behind theory that you will have difficulty finding someone to describe to you an authentic worthwhile application. I remain fairly convinced that the life insurance industry—in its agency problems—has potential game theoretic applications of value. It is important to remember that game theory deals with the situation where the protagonist has an intelligent adversary determined to maximize his own gains (or minimize his losses), which usually means he wants to make things hard for the protagonist. Hence the name, "game theory." I have constructed a game-theory model of an agency development problem, wholly hypothetical but, I think, interesting and suggestive just the same. I assume that two insurers are vying for a fixed, limited supply of potential agents becoming available. The model shows the quantitative interactions of such alternative strategies as flat additional services or compensation and higher first or renewal commissions and indicates how an optimum strategy can be selected—and its results—under simplified assumptions.

MR. JOHN M. BOERMEESTER: A calculation experiment was recently performed in the John Hancock under the direction of Mr. Frank S. Irish. The method might be classified separately as a technique for computing exact probability values.

The experiment concerned the problem of determining contingency reserves for possible adverse mortality experience for groups of life-annuity contracts. This subject has received some attention in the past. In particular, Messrs. Fretwell and Hickman reviewed this subject in a paper presented to the Society earlier this year. They used for illustration a model of ten lives which I had used in a paper earlier in 1956. Messrs. Fretwell and Hickman made the observation that the confidence limits obtained by the Monte Carlo method were subject to an undetermined random error and that the use of probability inequality theory, in general, produced unduly high bounds for confidence limit analysis.

Because of this criticism we wished to devise a computational system which could be used to produce exact probability values. This we believe Mr. Irish has accomplished by a system under which the calculation of an

annuity value is rounded to one-decimal position. Such a rounding which was used for the ten-life model reduced the number of possible annuity values from the order of millions to the much more tractable level of 250. In brief, the calculation process is an iterative one. The distribution of possible costs for analysis is calculated from the results obtained for $n - 1$ lives. The main point of importance concerning the method is that of restricting the average annuity values for two or more lives to one decimal position.

Table 1 gives the results obtained. A comparison to the values shown for the ten-life model discussed in the Fretwell-Hickman paper is interesting.

TABLE 1

ROUNDING METHOD (ONE-DECIMAL POSITION) UNIT ANNUITY COST FOR AVERAGE AND CONFIDENCE LIMITS OF 90 AND 95 PER CENT

ANNUAL INCOME PAYABLE TO THE TENTH LIFE	AVERAGE	CONFIDENCE LIMIT	
		90 Per Cent	95 Per Cent
1	11.499	13.8	14.4
2	11.500	13.9	14.5
5	11.499	14.5	15.2
10	11.498	15.4	16.2
25	11.497	16.7	17.7
50	11.497	17.5	18.6

It should be observed that the dispersion pattern of average annuity values derived from the calculations is remarkably narrow, as should be expected from the concept used for computation. These averages are to be compared to the annuity value of 11.496 as computed by the use of commutation columns. Incidentally, the time required on the IBM 1620 machine to complete the six analyses was less than three hours.

MR. RUPERT L. SUTTON: I believe that the North American actuary has not strayed so far from the three major fields of life insurance, employee benefit plans, and social insurance as has his British and European colleague.

I suggest that the Society should draw the attention of the profession to operations research; the time may well come when the mathematical techniques used in operations research become part of the Society's examinations, but for the time being they can be mastered as postgraduate studies.

It is noteworthy that the president and one of the directors of the Toronto Section of the Canadian Operational Research Society are actuaries, and a third actuary is a member of that section. The Canadian Association of Actuaries is currently sponsoring a series of meetings particularly for younger actuaries, and operations research is going to be the subject of the first meeting in 1965.

MR. PAUL M. KAHN: In the last few years game theory and utility theory have been applied to various insurance situations. Professor Karl Borch has developed a number of reinsurance models based on a utility-theoretic approach. He proceeds to define and to analyze the objectives of an insurance company and then to determine how various reinsurance treaties can operate to achieve these objectives.

From a consideration of the basic axioms of utility theory we are assured that an insurance company can establish a consistent preference pattern in choosing among different risk situations, that is, a rule by which the company can decide whether one profit distribution is preferred to another. These axioms also assure us of the existence of a policy function which provides some measure of the relative values of different amounts of money; this function is known in economic theory as the utility-of-money function. Borch has considered the application of these ideas, in conjunction with the relatively new tool of dynamic programming, to the distribution of surplus in a paper before the recent International Congress.

In another paper at the Congress, I consider the application of these ideas to the problem of experience rating in group insurance and develop the concept of the utility of the risk situation both to the insurer and to the insured group as a function of the initial reserve amount, the claims distribution, and the experience-rating formula. Also discussed is the choice of parameters in the experience-rating formulas.

The application to insurance problems of these several techniques is only in its first stages. Although we cannot yet imagine the ultimate nature of such applications, it is strongly to be urged, however, that we pursue these subjects to see what solutions they may provide for the problems of the industry, both now and in the future.

In the 1963 volume of *Skandinavisk Aktuarietidskrift*, Bohman and Esscher report on the work of a committee of Swedish actuaries set up in 1961 to investigate the use of electronic computers in calculating the distribution function of total claims on an insurance portfolio and the related stop-loss net premium. This report reviews various methods for calculating these functions exactly and chooses one which makes use of the char-

acteristic function of this distribution. Two related characteristic functions are derived which, by means of an inversion formula, produce two distribution functions bounding the desired function from above and below, and the differences between these functions can be made very small.

Two different types of short-cut methods are discussed. One type approximates these functions directly and includes approximating formulas based on the normal function and the incomplete gamma function; the other type applies approximations only after the distribution function has been transformed in a certain way—the method due to Esscher.

These various exact and approximate methods are applied to several claim distributions, both actual and hypothetical. The report contains several tables examining the validity of these approximations. Both the methods using the incomplete gamma function and the Esscher method are found to be very good. This and related reports in the same volume represent a very significant contribution both to the theory of risk and to the application of electronic computers to actuarial problems.

MR. BOERMEESTER: The John Hancock recently was faced with the problem of deciding what the level of a contingency fund for meeting adverse claim experience should be with respect to a group of approximately one hundred lives.

The underwriting attributes of this group were rather unusual, since the insurance was written for amounts in excess of regular limits. The ages ranged from 30 to 65. The sums insured varied from $2,000 to $160,000, and the medical rating at issue varied from standard to 750 per cent. Since the underwriting characteristics of this group had such a large range of values, it seemed appropriate that any decision concerning the level of contingency reserves should be guided, at least in part, by the distribution of possible mortality costs for a one-year period as determined by a Monte Carlo analysis.

Several Monte Carlo analyses in fact were made. Under each analysis, claim costs were obtained for one thousand different years of exposure for each life in the group. The distribution of the one thousand different claim costs for the group as a whole then was obtained to give a measure of the expected claims at the 95 and 99 per cent confidence limits. That is, we sought a measure of the amount of money which theoretically would be sufficient to cover claim costs at least 95 or 99 per cent of the time. Each trial run for one thousand years of exposure was accomplished on an IBM 1620 in a period of approximately one-half hour. Random numbers were generated by the general method suggested by Russell M. Collins in his

paper on a Monte Carlo technique which was published in *TSA*, Volume XIV.

This topic of discussion asks the intriguing question as to whether the method enabled management to "reach a rational decision." The results which were obtained from this Monte Carlo analysis were very helpful in arriving at a decision to establish a specific contingency fund goal. However, only time will tell whether or not any company does, in fact, "reach a *rational* decision" on a question of this particular type, since the assumptions concerning the expected mortality costs for each life may be subject to some conjecture.

MR. WILLIAM S. YORK: Early in 1964 we decided to begin the construction of a mathematical model of the daily computer operational cycle involved in a proposed data-transmission system connecting about eight hundred district offices in the United States with a central computer system. I will describe the system and its daily cycle briefly and point out some of the assumptions and objectives of the study.

Metropolitan is developing a system under which a computer will poll each district office twice daily, using specially designed electronic switching gear enabling the computer to carry on data transmission with a large number of districts simultaneously, using the regular telephone-switched network. Telephone contact in the district would be arranged through a specially designed console which will use a high-speed paper-tape reader for transmission of data and a modified Teletype machine for receipt of information from the home office.

Near the close of the district-office business day in the Eastern Time Zone, the home-office computer system in New York will begin calling Eastern Time Zone districts, proceeding to the other time zones as their business days end.

After the information is processed overnight, the computer system will again poll the districts in the early-morning hours before the beginning of the business day in each time zone, to return answers to the district's interrogations and also to inquire as to discrepancies found in the district's information during the course of the processing cycle.

Our initial feasibility studies of this data-communication system were made using estimated average times, either disregarding dispersion of such averages or assuming generous margins for safety.

The purposes of the study are to learn something of the various characteristics of the system, to estimate the statistical reliability of the time taken by the cycle, to verify our earlier calculations on the economics of the system, including the equipment and the modes of operation, to learn

something about the frequency of emergencies and the effects of various courses of remedial action, and to be able to evaluate the capacity of the system over all in relation to the capacities of the components of the system.

MR. HERBERT L. FEAY: My comments are on the function of the probability distribution of total claims.

It is difficult satisfactorily to fit a mathematical curve to a distribution of total claims alone. I would suggest that (1) the distribution of total claim payments be expressed as a function of two variables, the number of claims and the amount of each claim (these can then be studied separately), and (2) the distributions be in the form of ratios rather than amounts.

The basic information used to secure these ratio distributions can also be used to determine the probability of a claim of a specified amount.

MR. RUSSELL M. COLLINS, JR.: My recent paper in *TSA* describes a Monte Carlo method of estimation in connection with a group insurance problem. Such a method, or modification of it, has application in problems of retentions and reinsurance, financial projections, etc.

Financial analysis is essentially a question of the evaluation of the effect of management decisions on the financial operations of a company. The advent and rapid development of electronic computers have made it possible to build a model which will simulate these operations. To construct such a model is an ambitious undertaking fraught with many difficult problems and pitfalls. Perhaps the best approach to the project is to build a crude model, but an operating one, and then proceed to refine it piece by piece. A variation on this approach is to construct a management game which involves construction of such a model or algorithm. Advantages of this approach are: (1) management games are valuable tools for demonstrating the capabilities of the operations research team, with the use of a computer, in this area of "better management through better information"—in fact, it might be said that in this realm lies the real potential of computers to contribute to the successful operation of a business—and (2) it provides a "real-life" situation in which to further refine the model through the co-operation of *all* members of the management team. We have drafted a management game for a life insurance company. IBM has recently developed a life insurance company management game.

Cost-value relationships are very difficult to determine in many instances, since so little is really known about the cause-and-effect relations in the insurance business. For example, when management is contemplat-

ing a possible new product, it should know how much it can afford to invest in this product if it is to be profitable. This is almost impossible to answer, since it involves prediction of sales of this product, in the case of most companies. However, the question can be turned around to ask how much sales and when are required to make the product profitable, given a certain investment in the product. Management could then determine the amount to be invested and the production goals accordingly. Of course, even this is an oversimplification, since it ignores the effect of the product on the sale of other products.

At the Minnesota Mutual we have developed a method for measuring agency costs and returns. The method provides an absolute standard for measuring the effectiveness of an agency operation and could conceivably be the basis for the construction of a very valuable tool for agency management. Its major weaknesses are the usual ones: the difficulty and to some extent subjectivity of the expense breakdowns necessary and the assumptions which need to be made about the future. However, I believe that no valid method can avoid these problems.

Many of these approaches would be impossible or impractical without electronic computers. I believe that the companies which can search out and utilize the best of the new techniques and concepts of management science are the companies with the brightest future in our business. I believe that basic research and development in these areas is the responsibility of the actuarial profession.