A MATHEMATICAL MODEL FOR A
GROUP PENSION
PROGRAM

An Honors Thesis (ID 499)
by
Sharon M. O'Meara

Thesis Director

John A. Beekman, ASA

Ball State University
Muncie, IN
November 16, 1984

Expected date of graduation (Fall, 1984)
Table of Contents

I. Introduction ........................................... 1
II. Basics of a Pension Plan .............................. 3
III. Classical Definition of Immunization ............. 7
IV. Stochastic Models ...................................... 9
V. Gifford Fong Theory of Immunization .............. 11
VI. Description of the system ............................ 14
VII. The System
   A. Description of Programs
   B. Instructions for Use
   C. Reports
   D. Calculation of Durations
   E. List of Programs and Their Functions
   F. Printout of Programs
VIII. Implications of the Output ......................... 16
IX. Conclusion ........................................... 17
X. Footnotes ............................................. 13
XI. Bibliography .......................................... 19
Introduction

The progressive increase in the number and proportion of the retired section of the population is of growing concern today. The probable reduction of an individual's earning power upon leaving the work force must be planned for in the earlier stages of one's employment history. What resources can be drawn upon to survive once income from work is discontinued? In the past many have survived on social security or private savings. Drastic decreases in standard of living have been seen in the life styles of the elderly. Social Security is cutting back payments as it runs into more and more difficulties paying the increasing number of elderly. Economic security is a serious and increasingly important problem of the United States. One way an individual can ease the worries of income after retirement is to join a pension program either individually through IRA's or KEOGH's or through plans offered through the place of employment. Pension programs have grown significantly since the 1940's; however, they date back to the 1800's. This paper outlines what is necessary for a defined contribution pension plan to be successful in providing benefit payments at a future date. The organization is as follows: A brief outline on the structure of a pension plan giving rise to the need for immunization, a definition of classical immunization, followed by a more recent theory of immunization developed by Gifford Fong. A model of a specific pension plan will be
shown and a description of how to project cashflows will be given including a computer system developed to produce the future cashflow for the product. Finally, the results will be shown that are then used by an investment department for immunization purposes.
Basics of Pension Plan

'From the standpoint of the whole system of social economy, no employer has a right to engage men in any occupation that exhausts the individual's industrial life in 10, 20 or 40 years; and then leave the remnant floating on society at large as a derelict at sea.'¹ This states that there is an obvious problem of maintaining an adequate standard of living once past the productive, employable years of life. There are basically four methods of meeting the problem of superannuated employees. First, "the employee could be terminated without any further compensation or any retirement benefits as soon as the value of the employee's services is less than the salary being paid."² This is a disadvantage to the employee but great financial advantage for the employer. Another method of handling the superannuated employee is to retain the employee at the current level while the company absorbs the cost. Another undesirable method to the employer this time. A third method would be to retain the employee at a less demanding position. This being a little better than method two because a new, younger employee can fill the vacancy. This also reduces the cost of maintaining the older employee. However, none of these choices seem to be desirable for the employer or employee. An alternative to these methods is to establish a formal pension plan. A pension plan is established through employer and employee contributions into a fund throughout the working years of the employee. This then accumulates at a predetermined or going rate of interest until the employee reaches retirement age.
He will then begin to receive payments from the pension plan in lieu of his paycheck. This method has become very popular in the past forty years.

There are several advantages of pension plans to be considered. For the employer, the superannuated employee can be dismissed in a fair, reasonable manner without having to worry about the cost and inefficiency of retaining him. The company will remain desirable for young employees in that advancements can be made. The cycle would flow smoothly with the older retiring and younger filling their positions. Also, the employees will feel more secure knowing provisions have been made for them upon retirement and hopefully, will increase their morale and productivity.

Another advantage of a pension plan is for tax purposes. Employer's contributions are tax deductible, a big plus for the company. Also, investment income is not taxed until actually paid out. From the employee's viewpoint, the employer contributions do not constitute taxable income until actually received. At that point it is assumed the employee will be in a lower tax bracket.

If a company is to attract new employees, it must offer some type of retirement benefits. If it does not, it is at a strong disadvantage in the labor market. Hence, pension plans are a must for a company to survive.

Pensions are also a supplement to income after retirement. Social Security and individual savings also contribute to income. However, neither is adequate to maintain one's standard of living. Most individuals need a combination of
Social Security, private pensions, and personal savings. Also, it has been shown that people would rather spend their money as they earn it rather than put it into savings and not see it until many years down the road. Unexpected demands arise where use of the 'savings for retirement' money is needed immediately. A pension plan is a form of forced savings. This is needed if the individual wishes to maintain a relatively high standard of living after retirement.

The need for and advantages of pension plans have been clearly pointed out. However, the next problem is how is a company going to provide pension plans for their employees. Many sources are available to choose from. Insurance companies, trust departments of banks, corporate trustees all offer the service. The insurance industry first entered into the pension business with the issuance of the first annuity contract by Metropolitan Life Insurance Company in 1921. The problem of providing a pension plan is now passed from the company to the insurance company or other group to handle. The question remains as to how is one to guarantee payments upon retirement and how much will they be; a major concern of the employees.

The company that provides the pension plan creates a series of long term liabilities representing the obligation to pay a specific amount of money or provide income for a certain amount to annuitants. Investments must be made at the present time to meet these future demands. Such investments are made up of common and preferred stock, bonds, mortgages, real estate, and cash. All of these have different rates of return and different levels of risk. One first must
analyze the structure of the pension plan and make investments accordingly. Liability determinations are based on actuarial cost estimates. "Good pension administration includes close monitoring of the estimates and assumptions. The standard list of actuarial assumptions include mortality expectation, ..., expected levels of compensation, administrative costs, ages of retirement, and finally, anticipated investment earnings."4 Until recently, many life insurance companies did not have investment staffs that would permit them to follow the total return concept. A study on investment policies found, 'For most (insurance) companies, the labor, capital, and material resources employed in making investment decisions represent a negligible portion of total resources utilized by the companies.'5 New theories have been developed since the 1940's on how to invest to get the maximum yield and appropriate timing for pension plans.
Classical Definition of Immunization

'A portfolio of investments in bonds is immunized for a holding period if its value at the end of the holding period, regardless of the course of interest rates during the holding period, must be at least as large as it would have been had the interest-rate function been constant throughout the holding period.' Only recently has immunization of portfolios become a major concern for insurance companies. The above definition was written in 1971 by Lawrence Fisher and Roman L. Weil who then developed what is now known as the traditional theory of immunization. Immunization theory is a key concept of the investment division of insurance companies and, if accomplished successfully, can lead to large profits and a more flexible business.

The Fisher/Weil theory looks at an investor with x dollars now and wants y dollars at some time, t, in the future. Any deviation from the y dollars at time t is a measure of risk of the investment. The Fisher/Weil theory based their investment strategy on the duration of an asset. Duration is 'a number with dimension time attached to a stream of promised payments.' Mathematically:

$$D_{t_0} = \sum_{j=1}^{n} t_j P_{t_j} / \sum_{j=1}^{n} P_{t_j} - t_0$$

$D =$ Duration  
$T_j =$ Time  
$P_{t_j} =$ Present values at time $t_j$ of promised payments. 

From this they developed the immunization theorem. They first assumed interest is to be compounded continuously - call this function $i(t)$. They then assume if interest rates
change, all rates change by the same amount. In other words, if \( i_a(t) \) changes to \( i_b(t) \) then

\[
i_b(t) = i_a(t) + \Delta
\]

With these assumptions made, the immunization theorem states the portfolio is immunized at \( t_o \) if duration, \( D_{t_o} \), of the promised payments is equal to the desired holding period.

Therefore, an investor who wishes to be immunized from interest-rate fluctuations should have equal durations for assets and liabilities. Duration of a portfolio is a linear combination of the durations of its components. The investor can match asset and liability durations by purchasing a single-payment note whose duration is at least as long as the longest liability and combining this with assets with shorter durations to come up with the perfect match. This theorem should lead the investor to at least break even if all assumptions hold.

This theory has been developed with much more powerful theories now taking its place.
Stochastic vs Deterministic Models

The classical definition used a deterministic model when discussing the term structure of interest rates. "The term structure of interest rates exhibits the relationship among the yields on default free debt instruments of different maturities." This deterministic model, however, is inconsistent with the treatment of assets where the prices are determined under the assumption that returns on the assets are random variables, i.e. not deterministic. Phelim Boyle summarizes two methods to determine the price of a pure discount bond at time $t$ with maturity time $s$ and spot rate $r$. Both of these methods follow a stochastic or random model. It should be clear that a stochastic model is better suited to determine spot interest rates because one, it is consistent with the method used in determining returns on assets and two, it is a natural process assuming the market is efficient and investors act rationally. Furthermore, a stochastic process is "a mathematical model used to describe a natural process."  

The two methods developed in Boyle's paper are by Vasicek and by Cox, Ingersole and Ross. Both assume the spot rate follows a Markov or continuous process. The Cox, Ingersole and Ross method also eliminates the possibility of negative interest rates. It is very important to utilize a realistic model in determining the maturity structure of liabilities so the appropriate assets may be selected. This matching of the term of the assets in relation to the term of the liabilities
so as to reduce the possibility of loss due to change in interest rates is of the greatest importance because, "it is one of the three main factors within (the company's) control which can endanger the solvency of an office."\textsuperscript{10}

The results of the Vasicek and Cox, Ingersole and Ross methods make it possible to achieve immunization under the classical definition. There are differences in the mean terms in the deterministic and stochastic models. In the deterministic model, the mean term is equal to maturity date \( T \). The Vasicek model shows the mean term is less than \( T \) but is bounded by \( T \) as \( T \to \infty \). In the last model, the mean term is always less than \( T \). Remember, the mean term measures the riskiness of the bend. Hence, the stochastic models give rise to larger investments in longer term bonds because of the lower risk or less dramatic effect of an interest rate change.
Gifford Fong Theory of Immunization

Immunization involves the matching of the first moments of asset and liability cashflow. This protects against parallel movements in interest rates. Also, investment flexibility is provided in that cashflow matching is not required. However, a problem encountered with this technique is that non-parallel shifts in interest rates are not protected against. A new risk management strategy was developed by Gifford Fong and Oldrich Vasicek that addressed the risk of non-parallel movements in interest rates. This is a little more complicated than classical immunization since the second moment as well as the first moment is involved. The Gifford Fong Strategy aims for an optimal tradeoff between risk and return rather than minimizing the portfolio's immunization risk.

Fong purposes to achieve this optimal tradeoff between risk and return by maximizing the lower bound on the portfolio return. The lower bound is a confidence interval on the realized return for a given probability level.

The first condition necessary in the Gifford Fong strategy is the traditional matching of durations. Duration is the weighted average time of all the portfolio payments, the weights being the present values of the payment amounts.

Mathematically:

\[
\text{Duration} = \sum_{i=1}^{m} t_i C_i P_o(t_i) \div I_o
\]
\[ m = \text{number of portfolio payments} \]
\[ C_i = \text{Amount of payment due at time } t_i \]
\[ P_0(t) = \text{Discount function} \]
\[ I_0 = \text{Initial portfolio value or the sum of the present value of the payments.} \]

Another condition that must be met is the Mean Absolute Deviation Constraints. This says that the asset cash-flows must be more dispersed than the liability cash-flows. These two constraints will subject the portfolio to immunization risk from arbitrary or non-parallel shifts of interest rates.

A measure of immunization risk is denoted \( M^2 \). Mathematically:
\[
M^2 = \sum_{i=1}^{m} (t_i - H)^2 C_i P_0(t_i) \div I_0
\]

\( H = \text{investment horizon} \)

This is simply the second moment of future cash-flows or the weighted variance of times to payment around the horizon date. For a portfolio that adheres to the above two conditions:
\[
M^2 = \sum_{i=1}^{m} (t_i - D)^2 V^t A_t - \sum_{i=1}^{m} (t_i - D)^2 V^t L_t
\]

\( D = \text{Duration} \)
\( V^T = \text{Present value} \)
\( A_T = \text{Assets} \)
\( L_T = \text{Liabilities} \)

or the difference of the future cash-flows of assets and liabilities. Traditionally \( M^2 \), immunization risk, is minimized. Fong optimizes the risk/return trade-off by maximizing the lower bound of a rate of return confidence interval. Define \( D_s \) as a random variable representing an arbitrary change of
interest rate. Therefore the change in value of the portfolio assets and liabilities is $-M^2D_s$. The rate of return of the asset portfolio is

$$R = \hat{R} - aM^2\Delta_s$$

$R$ = Rate of return random variable

$\hat{R}$ = Target (expected) rate of return

$a$ = Constant varying by duration of the asset portfolio

$$\nabla = aM^2 \nabla_s$$

The confidence interval for $R$ can be represented as:

$$R = \hat{R} \pm k\nabla_R$$

$R$ = Confidence level.

Fong suggests maximizing the lower bound of this confidence interval also written as

$$\hat{R} - k \cdot aM^2\nabla_s$$

Maximizing this is the same as minimizing $M^2 - \lambda\hat{R}$

$$\lambda = 1/k \cdot a\nabla_s$$

The use of linear programming and the duality theory will accomplish the task of immunization.
Description of the System

It is necessary to give a simple example on how to project cashflows and describe what implications can be made from the output. I have chosen to use a group pension plan called the Growth Guarantee Contract (GGC) for which to project cashflows. The structure of the GGC is as follows:

X denotes the deposit period for a group, usually 12 months.

Y denotes the holding period. The company holds the money Y months at a guaranteed interest rate. Y usually ranges from two to five years.

Z denotes the disbursement period of the money back to the insured.

Expenses can either be deducted from the account, credited, or separately billed. Benefit payments can be made throughout the X-Y-Z periods, prorata, or not paid at all, LIFO. There are four combinations of billing/benefit payout options. All are accounted for in the system. The system contains a main program to project the cashflows, many subroutines used by the main program, a database of all sales made from July, 1983 to the present, and several matrices containing fund balances, deposits, disbursements, and interest earned.

It is of vital importance to keep the system updated each month with all of the new sales, fund balances etc. to receive an accurate cashflow projection. If this is not properly done, invalid conclusions may result. To keep it current, user-friendly programs are included to add new sales, insert fund balances, and make adjustments.
Several assumptions must be made before the cashflow can be projected. First is the amount of monthly deposit expected in future months. This is simply the total sale divided by the X period. If a policy is prorata, an assumption must be made as to how much the monthly benefit payments are expected to be. This is calculated by the underwriting department based in past experience. The deposits and benefit payments should be monitored to see if they are deviating from the original assumption. If so, an adjustment should be made through the ADJUSTMENTS program. This step is as important as keeping the database updated if accurate cashflows are to be projected.

The main program will take the sale from the database and project a ten year cashflow for each one. Totals are accumulated to produce the final reports. From the results the investment department can easily see the total dollar amount of inflows that are expected and how and when disbursements from benefit payments and maturities are made. Also, the present value of the inflows and outflows, M(0), the first and second moments, and D1- and D2, duration, are shown for each case and in total. Ultimately, matching of the second derivatives (D2) is desired. Following is a printout of the system and brief explanations where needed.
Introduction:

This system is designed to project the cashflows for the GGC sales since July, 1983. The cash flows are projected ten years into the future. Each sale is processed individually while the sum is accumulated.

A projection consists of three streams:

1). inflows consisting of deposits only.
2). outflows consisting of expenses, benefit payments and maturities.
3). an accumulation of the fund balance.

The final report contains an inflow monitor, outflow monitor, total projection and, if opted, projections for each individual record.

One may request the projection from any point in time from July of 1983 to ten years past the current month. Any projection made starting between July, 1983 and the current month uses the final balances as of the projection date. If a projection is requested for a future date, the most current fund balance is used to start the cashflow streams. Only sales existing at the projection date are used to produce the streams.

Underwriter Responsibilities

For this system to be accurate, the Underwriters must be sure to update it each month. Their primary responsibilities are to add the new sales each month, add fund balances for the existing records, and make adjustments that are necessary.

There are eleven possible adjustments, two of which require monitoring the benefit payments and deposits. The changes would be made to the benefit payment assumption field and expected monthly deposit field if they consistently vary from the original assumptions.

All adjustments can easily be made using the "Adjustments" program and new sales are entered using the "Newsales" program. Both are user friendly.

Using the System

The system must be run on an IBM PC equipped with an APL chip. To begin, insert an APL disk in disk drive A and hit control, Alt, Delete at the same time. Next, clear the workspace by typing ') CLEAR. Take out the APL disk and insert the cash flow disk. Load the program by typing ') COPY CASHFLOW. It will take a minute or two to complete this step. A final important step that must be done before running any of the programs is to tie the files so they can be accessed. This requires two commands as follows:

- 'DATA' □ (QUAD) FTIE 100
- 'NAMES' \ (QUAD) FTIE 200
The quote is the uppercase k and the quad is the upper case l. The system is now ready to run any program.

The options are:

- Newsales - to add new sales
- Newbal - to enter monthly fund balance
- Adjustments - to adjust existing records
- Program - to project the cash flows

Newsales and newbal should be run together monthly. 'Program' may be run at any time. Adjustments are stored for one period only.

**All adjustments for one month should be made at one time to prevent losing any of the net changes.**
# Records in Database

**1983:**

<table>
<thead>
<tr>
<th>Policy #</th>
<th>Company Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Carpenter's Severance &amp; Annuity</td>
</tr>
<tr>
<td></td>
<td>Frisch's Restaurant (12.55%)</td>
</tr>
<tr>
<td></td>
<td>Total Petroleum</td>
</tr>
<tr>
<td></td>
<td>Hanna Mining</td>
</tr>
<tr>
<td></td>
<td>Michigan Consolidated Gas</td>
</tr>
<tr>
<td></td>
<td>GWL Savings (12.56%)</td>
</tr>
<tr>
<td></td>
<td>GWL Savings (12.69%)</td>
</tr>
<tr>
<td></td>
<td>Tab Merchandising</td>
</tr>
<tr>
<td></td>
<td>Boscov's Department Store</td>
</tr>
<tr>
<td></td>
<td>Hydrotex</td>
</tr>
<tr>
<td></td>
<td>Rexham Corp.</td>
</tr>
<tr>
<td></td>
<td>Cassentino</td>
</tr>
<tr>
<td></td>
<td>Mobile Home</td>
</tr>
<tr>
<td></td>
<td>Anaheim Union H.S.</td>
</tr>
<tr>
<td></td>
<td>Pepsi-Cola</td>
</tr>
<tr>
<td></td>
<td>Oakland Unified School</td>
</tr>
<tr>
<td></td>
<td>Nabors Alaska</td>
</tr>
<tr>
<td></td>
<td>Camco</td>
</tr>
<tr>
<td></td>
<td>American Petroleum</td>
</tr>
</tbody>
</table>
### Records in Database

**1984:**

<table>
<thead>
<tr>
<th>Policy #</th>
<th>Company Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hudson Screw</td>
</tr>
<tr>
<td></td>
<td>Housing Authority of St. Louis</td>
</tr>
<tr>
<td></td>
<td>General Hospital of Everett</td>
</tr>
<tr>
<td></td>
<td>Robert C. Wilson</td>
</tr>
<tr>
<td></td>
<td>Schweiger Industries</td>
</tr>
<tr>
<td></td>
<td>City of Springfield</td>
</tr>
<tr>
<td></td>
<td>Sherwood Enterprises</td>
</tr>
<tr>
<td></td>
<td>Electro Corp.</td>
</tr>
<tr>
<td></td>
<td>Pool Arctic Alaska</td>
</tr>
<tr>
<td></td>
<td>KLA Instruments</td>
</tr>
<tr>
<td></td>
<td>Boscov's Department Store (12.85%)</td>
</tr>
<tr>
<td></td>
<td>First Michigan Cap. Corp.</td>
</tr>
<tr>
<td></td>
<td>Frisch's Restaurants (13.15%)</td>
</tr>
<tr>
<td></td>
<td>Harrison &amp; Crossfield</td>
</tr>
<tr>
<td></td>
<td>Whiting Corp.</td>
</tr>
<tr>
<td></td>
<td>Georgia Kraft</td>
</tr>
<tr>
<td></td>
<td>Fieldale Corp.</td>
</tr>
<tr>
<td></td>
<td>National Asbestos</td>
</tr>
<tr>
<td></td>
<td>Tandin</td>
</tr>
<tr>
<td></td>
<td>St. J udes (13.85%)</td>
</tr>
<tr>
<td></td>
<td>St. J udes (13.9%)</td>
</tr>
<tr>
<td></td>
<td>Cleveland Newspaper Pub.</td>
</tr>
<tr>
<td></td>
<td>Harrison &amp; Crossfield (14.07%)</td>
</tr>
<tr>
<td></td>
<td>Intercity Transit</td>
</tr>
<tr>
<td></td>
<td>Washington Forge</td>
</tr>
<tr>
<td></td>
<td>Manville (14.41%)</td>
</tr>
<tr>
<td></td>
<td>Accent Displays Inc.</td>
</tr>
<tr>
<td></td>
<td>American Petroleum</td>
</tr>
<tr>
<td></td>
<td>Panhandle Motor Services</td>
</tr>
</tbody>
</table>
Projection:

PURPOSE:
To project cash flow streams for each sale and accumulate totals for all sales since July, 1983. User may choose any date to make the projection. Any date prior to 7/83 will give all zeros. Any date past the date the 1st fund balances will start at the date of the most current fund balance. Durations can be calculated if user desires. The floating point arithmetic required for these calculations slows down the system considerably. Be prepared to spend an afternoon running "Projection".

CALCULATION OF DISBURSEMENTS:
1. Benefit = LIFO, Expenses = BILL
   Disbursement vector = 0

2. Benefits = LIFO, Expenses = DEBIT
   Max (.15, .00038 X FB) 
   FB 2,000

3. Benefits = PRORATA, Expenses = BILL
   Ben % assumption X FB

4. Benefits = PRORATA, Expenses = DEBIT
   2+3

CALCULATION OF FUND BALANCES:
FB (X+1) = FB(X) + Dep (X+1) = Disb (X+1) + 
[FB(X) + Dep (X+1) - Disb (X+1)] X (Int/12)

CALCULATION OF DURATION:
D0 = \sum_{t=0}^{n} t^0 A_t
D1 = \sum_{t=0}^{n} t^1 A_t
D2 = \sum_{t=0}^{n} t^2 A_t

A_t = \text{assets}
Setproj:

PURPOSE: Same as setproj except fund balances for current month have been entered and are used as beginning fund balances.

Adjustments:

PURPOSE: To change a factor of a record in the database.

Changes can be made to:

- Policy number
- Company name
- Policy type
- X-Y-Z period
- Interest rate
- Effective date
- Expense payment
- Annual benefit percent assumptions
- Expected monthly deposits

FUNCTIONS CALLED: Y-period, 2-period, Interest, Expenses

START PROGRAM: Type ADJUSTMENTS
Projection
Variable Table and Their Function

Accumulators:

INFT
SP
NDISB, NDISB, NF8
DEP, DISB, FBV, INT, MAT
RDEP, ROISB, RFB
TOTDEP, TOTDISB
TOTFB, TOTINT, TOTMAT
SRTPOL
DRT0, DRT1, DRT2
MDRT0, MDRT1, MDRT2
ADRT0, ADRT1, ADRT2
AMDRT0, AMDRT1, AMDRT2
DUR0, DUR1, DUR2,
MDURO, MDUR1, MDUR2,
ADURO, ADUR1, ADUR2,
AMDURO, AMDUR1, AMDUR2
DURANS
MKTINT
PRANS
SIZE
J, I

Interest
Single premiums
Deposits, Disbursement, Fund balance of new sales
Deposits, disbursements, fund balance, interest and maturities for current sale
Deposits, Disbursements, fund balance of renewal sales

Accumulate total

Holds policy numbers as they are read from "DATA"
DD, D1, D2 for outflows at credited interest rate
DD, D1, D2 for outflows at market interest rate
DD, D, D2 for inflows at credited interest rate
DD, D1, D2 for inflows at market interest rate

Temporary variables to accumulate durations as they are being calculated. Assigned a position in above vectors.

Answer if want to calculate duration
If calculating duration, holds market interest rate
Answer if print each sale

Size of database
counter for files, general

Used in calculating remaining time i.e. projection date
- effective date

Remaining time of policy
Remaining time from 7/83 i.e. projection date - 7/83
Sale information read from "DATA"

X, Y, Z periods
Total time of policy - X+Y+Z
Remaining time of policy
Type of disbursement for Z period
Number of quarterly deposits
Original Z period
Month starting disbursement period i.e. (X+Y+1)

Counter used to determine when to make quarterly disbursement
INSTRUCTIONS TO USE GCC CASHFLOW

Starting the system:

Only IBM PC's with an APL chip can run the system. One is located outside of Luke Girard's office, one is on 10th floor by David Wolpo, and one on 6th floor by Paul Erickson's office.

To begin insert the APL disk in drive A. This should be located right next to the PC. Boot up the system by hitting CTRL, ALT, DEL at the same time. About 45 seconds later a message "see describe" will appear. Clear the screen by typing )Clear. )is the uppercase semi colon. Remove the APL disk and insert the GCCF APL disk. Load new workspace by typing )LOAD CASHFLOW. If "workspace not compatible" appears type )COPY CASHFLOW. This takes about two minutes. Next insert the MATRICES Disk in drive A and type )COPY MATRICES. All information is now loaded. Reinsert the GCCF APL disk in drive A.

The system is now ready to run. Type INSTRUCTIONS for general instructions on how to enter information. There are several options available.

All APL characters are found on a STSC APL sheet located near the P.C.

IMPORTANT

Before starting two commands must be typed!

'DATA'   )FTIE 100
'NAMES'   )FTIE 200

'is uppercase k
[] is uppercase L

This must be done to be able to access the files.

Option 1: Add new sales. Type NEWSALES to begin. The user is prompted to enter all of the pertinent information for each sale. If a mistake was entered several things can be done to correct it. If it occurred before the 'Is this a new or renewal sale?' question hit CTRL ESC. This exits from the program. To re-enter simply re-type NEWSALES. If the error occurs after that question the following must be typed.

1. )FDROP 100 -1 is uppercase L
2. )FDROP 200 -1
3. FBMATRIX [100;1] ; is uppercase )
   [ is ; key
   a number will appear - say X
4. FBMATRIX [100;1]←X-1 (one less the number shown above)

A new sale can now be entered.
Option 2: Make adjustments to existing sales. Type ADJUSTMENTS to begin. The user is given eleven options on different adjustments to make. Several may take a couple of minutes to complete. The adjustment is complete when the question, 'Do you want to make another adjustment?' appears. The best way to correct an error is to make a negative adjustment or re-enter the original assumption. This should zero out any changes that were made.

Option 3: Enter new fund balance. Type NEWBAL to begin. This program enters fund balances, deposits, disbursements, and interest into different matrices. The matrices are FBMATRIX, DEPMATRIX, BENMATRIX, INTMA1RIX. If error occurs, the appropriate matrix entry must be found to search for policy number which is the first column of all matrices. Type FBMATRIX [(0 + 100); 5] is the uppercase I. Locate correct policy and count which entry is X. Type FBMATRIX [X (from above step); ] to locate the incorrect entry. Count its position, say y. To correct the entry type FBMATRIX [X; Y ← new entry.] This must be done for all matrices that may have received the incorrect answer. Also, if a deposit was entered wrong and a was or single premium sale, SPMATRIX must be corrected in a similar fashion.

Option 4: Project cashflows. Type PROGRAM to begin. A series of questions follows. Once the answers are entered the projection begins. It may take an afternoon to run. All reports are produced after the projection is complete. I suggest beginning it in the morning. If for any reason it must be stopped hit CTRL BREAK (Upper right corner). This interrupts the program. Corrections can be made to the programs. Type → □ LC to continue → is the ] key, □ is uppercase L. Be sure not to change any variables like X, Y, Z, J, or totals. If PROGRAM is stopped and restarted by typing PROGRAM, the whole process is started over. If )RESET is typed the position is lost. → □ LC does not work.
Reports Generated from Projection

Illustration:

Inflow Monitor

1. Outstanding future deposits at beginning of period $5,000
2. New sales in month 1,000
3. Renewed sales 2,000
4. Adjustments 500
5. Expected in-month deposits (1,500)
6. Outstanding future deposits at end of period 7,000

Illustration:

Outflow Monitor

<table>
<thead>
<tr>
<th>Cash Items</th>
<th>Actual</th>
<th>Projected</th>
<th>Disbursement Cashflow Movement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Funds at beginning</td>
<td>$25,000</td>
<td>$25,000</td>
<td>$0</td>
</tr>
<tr>
<td>2. Single premiums</td>
<td>2,000</td>
<td>0</td>
<td>2,000</td>
</tr>
<tr>
<td>3. Annual premiums</td>
<td>1,700</td>
<td>1,500</td>
<td>200</td>
</tr>
<tr>
<td>4. Disbursements</td>
<td>(300)</td>
<td>(350)</td>
<td>50</td>
</tr>
<tr>
<td>5. Maturities</td>
<td>(1,000)</td>
<td>(900)</td>
<td>(100)</td>
</tr>
<tr>
<td>6. Interest credits</td>
<td>3,000</td>
<td>2,900</td>
<td>100</td>
</tr>
<tr>
<td>7. Funds at end of period</td>
<td>$30,400</td>
<td>$28,150</td>
<td>$2,250</td>
</tr>
</tbody>
</table>

Non-cash Items (excludes single premiums)

8. New sales  $1,000
9. Renewal sales  2,000
10. Adjustments  500

11. Total movement  $5,750
The inflow monitor will show what the forward commitment position ought to be (7,000) and how it changed. The outflow monitor will show how much the company should have invested and disbursed (30,400) and how it changed. It will also show why the future disbursement cashflows have changed since the beginning of the period. These monitors, however, do not show changes due to changes in disbursement assumptions.

To keep track of adjustments, an adjustment report can be produced. This will show the adjustments for that month only. It is displayed for 120 time periods to show the net monthly change. Adjustments are broken down into changes due to adjustment in:

X period - total deposits expected
Benefits - total benefit payments made
Interest - change in interest rates
Expenses - How expenses paid
Y period - Holding period
Z period - Disbursement period
Calculation of Durations

\[ D_0 = \sum_{t=0}^{n} v^t A_t \]

\[ n = \text{number of months remaining in contract} \]

\[ A_t = \text{Assets} \]

\[ D_1 = \sum_{t=0}^{n} t v^t A_t \]

\[ D_2 = \sum_{t=0}^{n} t^2 v^t A_t \]

\[ M_1 = D_1 \div D_0 \]

\[ M_2 = D_2 \div D_0 \]

Zero, first, and second moments, Duration 1, and Duration 2 were calculated for assets and liabilities. They were also calculated at the interest rate stated in the contract as well as a common market rate for all contracts. The user determines this rate. They are displayed as follows:

<table>
<thead>
<tr>
<th>Outflows</th>
<th>Inflows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cred. Int.</td>
<td>Market</td>
</tr>
<tr>
<td>D0</td>
<td></td>
</tr>
<tr>
<td>D1</td>
<td></td>
</tr>
<tr>
<td>D2</td>
<td></td>
</tr>
<tr>
<td>M1</td>
<td></td>
</tr>
<tr>
<td>M2</td>
<td></td>
</tr>
<tr>
<td>Program</td>
<td>Function</td>
</tr>
<tr>
<td>------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>System translation</td>
<td>APL keyboard</td>
</tr>
<tr>
<td>Turnprinter</td>
<td>Start printer on/off</td>
</tr>
<tr>
<td>Start</td>
<td>Start printer</td>
</tr>
<tr>
<td>Stop</td>
<td>Stop printer</td>
</tr>
<tr>
<td>Printrep</td>
<td>Displays cashflow for each sale</td>
</tr>
<tr>
<td>Duration</td>
<td>Prints durations, D0, D1, D2, M1, M2, for each sale</td>
</tr>
<tr>
<td>Totals</td>
<td>Prints final totals for all sales</td>
</tr>
<tr>
<td>In monitor</td>
<td>Inflow report</td>
</tr>
<tr>
<td>Out monitor</td>
<td>Outflow report</td>
</tr>
<tr>
<td>Adjrep</td>
<td>Displays total adjustments made to database and the net change in position</td>
</tr>
</tbody>
</table>

**Instructions**

General instructions to use system

**Program**

Core program to project cash-flows and make adjustments

**Projection**

Projects cashflow for each sale 10 years into the future

Stores totals for single premium sales separately

**Totsp**

Determines remaining time from projection date to end of contract. Sets x, y, z to appropriate lengths.
Program
Adjustments

<table>
<thead>
<tr>
<th>Program</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y period</td>
<td>Allows changes to be made in database</td>
</tr>
<tr>
<td>Z period</td>
<td>Makes adjustments to specific items.</td>
</tr>
<tr>
<td>Interest</td>
<td>Add sales each month</td>
</tr>
<tr>
<td>Expenses</td>
<td>Updates fund balance each month</td>
</tr>
<tr>
<td></td>
<td>Determines which fund balance to use to start projection</td>
</tr>
<tr>
<td></td>
<td>How records are stored</td>
</tr>
<tr>
<td></td>
<td>Contains numerical information</td>
</tr>
<tr>
<td></td>
<td>Contains company names</td>
</tr>
<tr>
<td></td>
<td>Matrix of all sale fund balances. Size 100 x 50</td>
</tr>
<tr>
<td>New sales</td>
<td></td>
</tr>
<tr>
<td>Newbal</td>
<td></td>
</tr>
<tr>
<td>Set proj</td>
<td></td>
</tr>
<tr>
<td>Set proj</td>
<td></td>
</tr>
<tr>
<td>Set up of database</td>
<td></td>
</tr>
<tr>
<td>Data</td>
<td></td>
</tr>
<tr>
<td>Names</td>
<td></td>
</tr>
<tr>
<td>FB matrix</td>
<td></td>
</tr>
</tbody>
</table>

Similar matrices for deposits, disbursements, interest, adjustments, single premium deposits
Start Printing

SYSTEMTRANSLATION(3)
SYSTEMTRANSLATION N O D E S
effective characters 0 1 2 3
on OFF 126 Change printer to APL characters

UNIPRINTER(3)
UNIPRINTER ON OFF; OFF
effective characters (ONOFF=ON, OFF), 1 OFF OFF 126 Turns printer on/off

SET(3)
SET
SYSTEMTRANSLATION 3
UNIPRINTER ON

STOP(3)
STOP
UNIPRINTER OFF

Also turns printer on
Input duration table for each row:

```
SUB-TION

(1) SUB-TION
(2) and: [[1176]'SUB-TION' OUTFLOWS'.(15p')'. 'INFLows'
(3) and: [[1176]'SUB-TION' CRED. INT. MARLET CRED. INT. MARLET'
(4) and: [[1176]'SUB-TION' CRED. INT. MARLET CRED. INT. MARLET'
(5) and: [[1176]'SUB-TION' CRED. INT. MARLET CRED. INT. MARLET'
(6) and: [[1176]'SUB-TION' CRED. INT. MARLET CRED. INT. MARLET'
(7) and: [[1176]'SUB-TION' CRED. INT. MARLET CRED. INT. MARLET'
(8) and: [[1176]'SUB-TION' CRED. INT. MARLET CRED. INT. MARLET'
(9) 1970
```

(10) v
Print totals at end of projection:

```
   TOTALS
  1. S.TEMPLATE
  2. TEMPLATE
  3. ODF=1.0
  4. * 0.175
  5. end(1) " TOT"
  6. end(1) " TOTALS"
  7. end(1) " TOT"
  8. end(1) " TOT"
  9. end(1) " TOT"
 10. end(1) " TOT"
 11. " TOT"
 12. " TOT"
 13. " TOT"
 14. " TOT"
 15. " TOT"
 16. " TOT"
 17. " TOT"
 18. " TOT"
 19. " TOT"
 20. " TOT"
 21. " TOT"
 22. " TOT"
 23. " TOT"
 24. " TOT"
 25. " TOT"
 26. " TOT"
 27. " TOT"
 28. " TOT"
 29. " TOT"
 30. " TOT"
 31. " TOT"
 32. " TOT"
 33. " TOT"
 34. " TOT"
 35. " TOT"
 36. " TOT"
 37. " TOT"
 38. " TOT"
 39. " TOT"
 40. " TOT"
 41. " TOT"
 42. " TOT"
 43. " TOT"
 44. " TOT"
 45. " TOT"
 46. " TOT"
 47. " TOT"
 48. " TOT"
 49. " TOT"
 50. " TOT"
 51. " TOT"
 52. " TOT"
 53. " TOT"
 54. " TOT"
 55. " TOT"
 56. " TOT"
 57. " TOT"
 58. " TOT"
 59. " TOT"
 60. " TOT"
 61. " TOT"
 62. " TOT"
 63. " TOT"
 64. " TOT"
 65. " TOT"
 66. " TOT"
 67. " TOT"
 68. " TOT"
 69. " TOT"
 70. " TOT"
 71. " TOT"
 72. " TOT"
 73. " TOT"
 74. " TOT"
 75. " TOT"
 76. " TOT"
 77. " TOT"
 78. " TOT"
 79. " TOT"
 80. " TOT"
 81. " TOT"
 82. " TOT"
 83. " TOT"
 84. " TOT"
 85. " TOT"
 86. " TOT"
 87. " TOT"
 88. " TOT"
 89. " TOT"
 90. " TOT"
 91. " TOT"
 92. " TOT"
 93. " TOT"
 94. " TOT"
 95. " TOT"
 96. " TOT"
 97. " TOT"```
OUTFLOW MONITOR FOR "(#MONTH),"/"(#YEAR)

1. FUNDS AT BEGINNING OF PERIOD =, (8 0 $TOTFLC(TIME+1)), (59 ')
2. SINGLE PREMIUMS =, (8 0 $SPC(TIME+2))
3. ANNUAL PREMIUMS =, (8 0 $((TDFLPC(TIME+2))-$SPC(TIME+2)))
4. DISBURSEMENTS =, (8 0 $((TDFLPC(TIME+2))-$TOTMATC(TIME+2))))', „)
5. MATURITIES =, (8 0 $TOTMATC(TIME+2)), „)
6. INTEREST CREDITS =, (8 0 $TOTINTC(TIME+2))

7. FUNDS AT END OF PERIOD =, (8 0 $TOTAL)

OUTFLOW MONITOR FOR "(#MONTH),"/"(#YEAR)

8. NEW SALES =, (8 0 $($/NDFP))
9. RENEWAL SALES =, (8 0 $($/RDFP))
10. ADJUSTMENTS =, (8 0 $($/ADJU5))
11. TOTAL MOVEMENT
ADJUSTMENT BREAKDOWN FOR ',(BP MONTH),'/,(BP YEAR)

G 31 32

---

h. (1) 76 **
\n(2) 176 **
(3) h. (1) 76 **
(4) h. (1) 76 **
(5) h. (1) 76 **
(6) h. (1) 76 **
(7) h. (1) 76 **
(8) h. (1) 76 **
(9) h. (1) 76 **
(10) h. (1) 76 **
(11) h. (1) 76 **
(12) h. (1) 76 **
(13) h. (1) 76 **
(14) h. (1) 76 **
(15) h. (1) 76 **
(16) h. (1) 76 **
(17) h. (1) 76 **
(18) h. (1) 76 **
(19) h. (1) 76 **
(20) h. (1) 76 **
(21) h. (1) 76 **
(22) h. (1) 76 **
(23) h. (1) 76 **
(24) h. (1) 76 **
(25) h. (1) 76 **
(26) h. (1) 76 **
(27) h. (1) 76 **
(28) h. (1) 76 **
(29) h. (1) 76 **
(30) h. (1) 76 **
(31) h. (1) 76 **
(32) h. (1) 76 **
(33) h. (1) 76 **
(34) h. (1) 76 **
(35) h. (1) 76 **
(36) h. (1) 76 **
(37) h. (1) 76 **
(38) h. (1) 76 **
(39) h. (1) 76 **
(40) h. (1) 76 **
(41) h. (1) 76 **
(42) h. (1) 76 **
(43) h. (1) 76 **
(44) h. (1) 76 **
(45) h. (1) 76 **

---

This page contains a breakdown of adjustments made to inflows and outflows, focusing on changes in interest rates and expected monthly deposits.
HREP.com

* H + H [1,176]<5 > #INTADJ[100+113]
* H + H [1,176]<5 0 #E<EFADJ[100+113]
* H + H [1,176]<(5 0 #ADJUST[100+119])
* H + H [1,176]<(5 0 #ZFDJUST[100+119])

STOP
GENERAL INSTRUCTIONS

**GCC CASH FLOW PROJECTION**
**AUGUST, 1934**

GENERAL INSTRUCTIONS

* BEFORE STARTING THE SYSTEM THE FILES MUST BE TIED TO BE ACCESSED. *
  * TIE FOLLOWING: *
  * "DATA" OF THE 100 *
  * "NAMES" OF THE 200 *

* ALL ANSWERS MUST BE IN THE FORM OF Y OR N OTHERWISE A LENGTH *
  * ERROR WILL OCCUR. *

* ALL FUND BALANCES MUST BE ENTERED IN THOUSANDS. *
  * (i.e. 2,000.00) = 2000) *

* ALL DATES MUST BE ENTERED IN NUMBER FORM. *

* A, I, AND Z PERIOD MUST BE ENTERED IN MONTHS NOT YEARS. *

* ALL PERCENTAGES MUST BE ENTERED IN DECIMAL FORM. *

* COMPANY NAMES MUST BE LESS THAN 25 CHARACTERS LONG. *
Core program to project cashflows and make adjustments:

```
PROGRAM [IO
PROGRAM

CASHFLOW PROJECTION INSTRUCTIONS:
1. ALL X, Y, Z PERIODS MUST BE ENTERED IN MONTHS NOT YEARS.
2. VALID RESPONSES TO QUESTIONS:
   1 FOR YES
   N FOR NO
3. ALL DATES MUST BE ENTERED IN NUMBER FORM.
4. ALL PERCENTS MUST BE ENTERED IN DECIMAL FORM.
5. ALL BALANCES MUST BE ENTERED IN THOUSANDS.
6. NAMES MUST BE LESS THAN 25 CHARACTERS.

ENTER CURRENT MONTH: * CMONTH+0
ENTER CURRENT YEAR: * CYEAR+0
HAVE THE FUND BALANCES BEEN ENTERED FOR THIS DATE? * ENTRANS+0
WHAT MONTH DO YOU WANT TO PROJECT CASHFLOWS FROM? * PMONTH+0
WHAT YEAR DO YOU WANT TO PROJECT CASHFLOWS FROM? * PYEAR+0
DO YOU WANT TO ADD NEW MONTHLY FUND BALANCES? * MFIBANS+0
ENTRANS='Y'/'NEWBAL'
ARE THERE NEW SALES TO ADD? * NSAINS+0
NSAINS='Y'/'NEWSALES'
ARE THERE ADJUSTMENTS TO BE MADE? * ADJANS+0
ADJANS='Y'/'ADJUSTMENTS'

((PYEAR=CYEAR) ((PYEAR=CYEAR) ((PMONTH<=CMONTH))) (ENTRANS='Y') 'SETPROJ'
((PYEAR=CYEAR) ((PYEAR=CYEAR) ((PMONTH<=CMONTH))) (ENTRANS='N') 'SETPROJ'
MONITOR
MONITOR
```
*INITIALIZATION OF VARIABLES:*

- TOTEXP = TOTISB = TOTFE = TOTTHAT = 12 / 0
- INT = 12 / 0 = TOTINT = 12 / 0
- 5D = 12 / 0 = ACCUMULATE SINGLE PREMIUMS.
- 5DPS = 12 = ACCUMULATE NEW SALES.
- NEEP = DIPS = NFB = 12 / 0 = ACCUMULATE FUTURE SALES.
- TOTFCLJ = 12 / 0 = TO SORT BY POLICY NUMBER.
- 5DTR = MRTR = AMTR = AMTR1 = 12 / 0 = VECTOR OF DURATIONS.
- 5DTR1 = AMTR1 = AMTR1 / 0 =
- 5DTR2 = AMTR2 = 12 / 0 =
- DUR = DUR + DUR1 / 0 =
- DUR1 / 0 =
- ANS = 10 / 0 = "DO YOU WANT TO CALCULATE DURATION?"
- ANS = 10 / 0 = "DURANS = ?"
- (DURANS = 'Y'/ (ANS = 10 / 0) / "MULTINTC"
- ANS = 10 / 0 = "DO YOU WANT TO PRINT THE CASH FLOW FOR EACH RECORD?"
- ANS = 10 / 0 = "FR=ANS".
- FILES READ FROM "DAT=" AND "NAMES".

SIZE = CPSIZE 100 = SIZE OF DATABASE.

*ACCOUNT FOR RECORDS:*
- ANS = 10 / 0 = "J=SUMI"
- LOOP = J (SIZEX23) / "+0"

*REINITIALIZE VARIABLES FOR EACH RECORD.*
- DIF = FB = INT = MAT = DIPS + 12 / 0
- FLAG =
- DUR + DUR1 / 0 = DUR2 / 0 =
- DUR2 / 0 =
- AMUB + AMUB1 + AMUB1 / 0 = AMUB2 + AMUB2 / 0
- INFO 0 = SPREAD 100, J = READ NML RECORD
- SORTFCLJ = INFO0 + 5J
- TM = (FYEAR - (INFOC32, 33) / 12) + (MONTH - (INFOC62, 27J))
- TIME = (FYEAR / 33 / 12) + (MONTH / 7)

(T = 0 / "J+1"
(T = 0 / "+LOOP"
(T = 0 / "FLAG = X = 0 + 100 ; 11"
(T = 0 / "FOMATI = FORMAT = 0 + 150 / 50 / " TIME-
(T = 0 / "SORTFCLJ = PCLMATECJ / " FC111 = FUNDALJ"
(T = 0 / "INFOC11, 12" = INFOC14, 15J = Z = INFOC17, 18J = M = x + y + z
(T = 12 / "+120"
(T = 0 / "x = 2"
(T = 0 / "+COMM"
(T = 0 / "x = 2"
(T = 0 / "+COMM"
(T = 0 / "x = 2"
(T = 0 / "x = 2"
(T = 0 / "+1"
(T = 0 / "+COMM"
(T = 0 / "y = 0 + 12"
(T = 0 / "+COMM"
(T = 0 / "+COMM"
I don't understand the content of the image.
1: TOTFB*TOTFB+FB 2: TOTMAT*TOTMAT+MAT
1: TOTLIT: TOTLIT: TOTLIT: INT
1: FRLMEM='1' // PRINTREP
1: J=1(SIZE(2)-1) // TOTALS
1: (INFO[55]='1') // SUB
1: ACCUMULATE FUTURE DEPOSITS.
1: (INFO[55]='1' && INFO[55]='2') // RETURN
1: REP+REP+SEP
1: RISP+RISP+DISP
1: REP+REP+FB
1: NEXT=J+J+1
1: SINGLE
1: ACCUMULATE NEW DEPOSITS.
1: SUB+NEF+NEF+IEF
1: NSISB+NSISB+DISB
1: NFE+RFB+FB
1: J=J+1
1: ACCUMULATE SINGLE PREMIUMS.
1: +LCOP
1: +
Sets $x, y, z$ periods

1. $x+X-T$
   - $T+O$
   - $\text{FLAG+1}$

2. $x2$
   - $x=0$
   - $T+O$
   - $\text{FLAG+1}$

3. $x2$
   - $T+T-x$
   - $x=0$

4. $y+1-T$
   - $T+O$
   - $\text{FLAG+1}$

5. $t+T-y$
   - $t+O$
   - $\text{FLAG+1}$

6. "$13$

"ADJUSTMENTS"

"LOOP: ENTER POLICY NUMBER OF RECORD TO BE ADJUSTED: " ' POL

'ENTER TYPE OF ADJUSTMENT YOU WISH TO MAKE:'

' 1- POLICY NUMBER'
' 2- COMPANY NAME'
' 3- POLICY TYPE, I.E. GGCH'
' 4- X PERIOD'
' 5- Y PERIOD'
' 6- Z PERIOD'
' 7- INTEREST RATE CREDITED'
' 8- EFFECTIVE DATE'
' 9- PAYMENT OF EXPENSES'
' 10- ANNUAL BENEFIT PERCENT ASSUMPTION'
' 11- MONTHLY DEPOSIT ASSUMPTION'

ANS:"
OLD+120*0+NEW+120*0

LOOP1: a(COUNT(x+1))/'OLD+NEW(COUNT)+ADJ[42+14]' COUNT+COUNT+1
   a(COUNT(x+1))/'+LOOF1'
   ADJ[11,12]+2*(TEM+2*')
   a(ANS+11)/'ADJ[42+14]+TEMP1'
   X+ADJ[11,12]
   a(T-X)(')/X+X-T'
   a(T-(ADJ[11,12]))(')/X+0'
   COUNT+2

LOOP2: a(COUNT(x+1))/'NEWDEP(COUNT)+ADJ[42+14]' COUNT+COUNT+1
   a(COUNT(x+1))/'+LOOF2'
   ADJUST+1+ADJUST+(NEWDEP-OLDDEP) MOD 12
   ADJ OFFPLACE 100,1

*END

T V E 1:(ANS#5)/*SIX'
   'ENTER NEW Y PERIOD': 0 TEMP+0
   ADJ[14,15]+2*(TEM+2*')
   ADJ OFFPLACE 100,1
   *END

SIX: a(ANS#6)/*SEVEN'
   'ENTER NEW Z PERIOD': 0 TEMP+0
   ADJ[17,18]+2*(TEM+2*')
   ADJ OFFPLACE 100,1
   *END

SEVEN: a(ANS#7)/*EIGHT'
   'ENTER NEW INTEREST RATE TO BE CREDITED': 0 TEMP+0
   ADJ[19,15]+5*(TEM+5*')
   ADJ OFFPLACE 100,1
   *END

EIGHT: a(ANS#8)/*NINE'
   'ENTER MONTH OF NEW EFFECTIVE DATE': 0 NEW+0
   ADJ[26,27]+2*(NEWM,2*')
   'ENTER DAY OF NEW EFFECTIVE DATE': 0 NEW+0
   ADJ[29,30]+2*(NEWD,2*')
   'ENTER YEAR OF NEW EFFECTIVE DATE': 0 NEW+0
   ADJ[32,33]+2*(NEWY,2*')
   ADJ OFFPLACE 100,1
   *END

NINE: a(ANS#9)/*TEN'
   'ENTER 1 IF EXPENSES ARE BILLED OR 2 IF DEBITED': 0 ADJ+0
   ADJ OFFPLACE 100,1
   *END

TEN: a(ANS#10)/*ELEVEN'
   'ENTER ANNUAL BENEFIT PERCENT. ASSUMPTION': 0 TEMP+0
   SUI+1 SUI add's record position
   PROJECTS 85% of old assumption
   OSAVE+DISB save all adjustments
   ADJ[36,31]+5*(TEM+5*') insert new assumption
   ADJ OFFPLACE 100,1
   PROJECTS continue old new assumption
   OSAVE+DISB save all adjustments
   ADJUST+ADJUST+(OSAVE-JSAVE) MOD 12
   *END

ELEVEN: a(ANS#11)/*END'
   'ENTER AMOUNT OF MONTHLY DEPOSITS EXPECTED': 0 TEMP+0
   TEM+4*(TEM+4*')
   'IS THERE A NEW X PERIOD ALSO?' 0 RES+0
   a(RES='Y')/*FOR'

*END

*FR
*PERIOD(CJ)
*PERIOD
$11+1
$NS+10
PROJECTION
OSAVE+DISB
ADJ(14, 15)+2x(TEMP, 2p', '')
ADJ OFREPLACE 100, SNI insert new adjustment in .DATA'
PROJECTION
NSAVE+DISB
ZADJUST+ZADJUST+(NSAVE-OSAVE) saves all adjustments to a period
40
• INTEREST(I)
  INTEREST
  SUI+1
  ANS+10
  PROJECTION
  OSAVE+DISB
  AD(J(19+15)+5p(TEMP, 5p'))
  ADJ OUTFPLACE 100, SUI
  INSERT new interest row in 'DATA'
  PROJECTION
  NSAVE+DISB
  INADJ+INTADJ+(NSAVE-OSAVE)
  saves all adjustments to interest row

• EXPENSES(L40)
  EXPENSES
  SUI+1
  ANS+10
  PROJECTION
  OSAVE+DISB
  AD(J(35)+TEMP
  ADJ OUTFPLACE 100, SUI
  INSERT new expense billing in 'DATA'
  PROJECTION
  NSAVE+DISB
  INADJ+EXPADJ+(NSAVE-OSAVE)
  saves all adjustments to expenses
? NEWSALES
* ADDS NEWSALES TO THE DATABASE DATA AND NAMES.
CONT: ENTER POLICY NUMBER OF NEW SALE: 'O NUM+O
' ENTER COMPANY NAME - NO MORE THAN 25 CHARACTERS:' 'O NAME+O
' ENTER POLICY TYPE - GC, GC1, GC2, 2-GC2, 2-GC3, 2-GC4, S-GC1: 'O TYPE+O
' ENTER 1-LIFE OR 2-SECONDARY FOR BENEFIT PAYMENTS: 'O PAI+O
' ENTER CONTRACT TYPE - 1-MAIN OR 2-RIDER:' 'O XTYPE+O
' ENTER 1 IF EXPENSES ARE BILLED OR 2 IF DEBITED:' 'O EXP+O
' ENTER NUMBER OF MONTHS IN X PERIOD, ENTER 1 IF SINGLE:' 'O X+O
' ENTER NUMBER OF MONTHS IN Y PERIOD: 'O Y+O
' ENTER NUMBER OF MONTHS IN Z PERIOD: 'O Z+O
' IF Z PERIOD IS NOT 0:
  ' ENTER 1 IF REGULAR Z PERIOD.
  ' ENTER 2 IF BULLET OUT Z PERIOD.
  ' ENTER 0 IF Z PERIOD IS 0.
ZTIP+O
' ENTER INTEREST RATE CREDITED:' 'O INT+O
' ENTER MONTH OF EFFECTIVE DATE:' 'O MDATE+O
' ENTER DAY OF EFFECTIVE DATE: 'O DDATE+O
' ENTER YEAR OF EFFECTIVE DATE: 'O YDATE+O
' ENTER ANNUAL BENEFIT PERCENT ASSUMPTION:' 'O BEN+O
' ENTER AMOUNT OF TOTAL SALE IN THOUSANDS: 'O TOTSALE+O
' ENTER AMOUNT OF MONTHLY DEPOSITS EXPECTED IN THOUSANDS.'
' ENTER TOTAL AMOUNT OF SALE IF SINGLE DEPOSIT.'
DEF+O
' ENTER FUND BALANCE IN THOUSANDS: ' O F handjob
' IS THIS A 1-NEW SALE OR 2-RENEWAL SALE?' 'O NEW+O
DATA+NUM, ' .TYPE, ' .PAY, ' .2p(X, 2e' ) O DATA+DATA, ' ,2p(1, 2e' )
DATA+DATA, ' ,2p(Z, 2e' ) O DATA+DATA, ' ,5p(INT, 5e' )
DATA+DATA, ' ,2p(MDATE, 2e' )
DATA+DATA, ' ,2p(DEATE, 2e' ) O DATA+DATA, ' ,2p(YDATE, 2e' )
DATA+DATA, ' ,EXP, ' ,5p(BEN, 5e' )
DATA+DATA, ' ,4p(DEF, 4e' )
DATA+DATA, ' ,6p(FB, 6e' )
DATA+DATA, ' ,6p(TOTSALE, 6e' )
CHAR+NUM, ' ,25p(NAME, 25e' )
CHAR+CHAR OFAPPEND 200
DATA+DATA OFAPPEND 100
T*(((YDATE)-B3)*12)+((MDATE)-7)    Enter policy number and fund balance in FEBMAT
NUMSALE+FBMAT[100:1]
FBMAT[100:1]:11+&NUM
FBMAT[100:1]:11+&FB
FMATRIX[100:11]+NUMSALE+1
' DO YOU WISH TO ENTER ANOTHER NEW SALE?' Loop if more sales to add
*('Y'=1+O): CONT
NEWFP 
"ENTER RECOMMENDED NEW FUND BALANCES:" < UNIFORM
"ENTER RECOMMENDED FUND BALANCES:" < UNIFORM
THESUM=(MINUS-FLFP-1500.I 
(LIGHTNTH-7) Column new fund balances are to be printed
(FLFP+TPOLICY) : Vector of old policy numbers

OPTIMUM}(100:1) # of records in database
LOC:="ENTER FUND BALANCE FOR POLICY NUMBERS:" POLICY
NFE+0
THESUM= (T+1)NF, 
INSERT new fund balance in TBMATRIX
TEMP+OFFSET 100.J
TEMP=FLFP+160. 
(8NF, 60"
NEW+TEMP 550
IF (NEW="1") (NEW="2") "TEMP" "0" "New/Revised rates are changed to old each month"
TEMP OFFSET 100.J. 
INSERT new fund balance in "Data"
NF+1
ENDC "END OF"
"END OF POLICIES."
finds correct fund balances for project
Structure of Names Calculation

Policy Number

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
Implication of the Output

This program takes one line of business from a medium sized company and calculates the first and second moments. This analysis can then be sent to the investment department, so they can invest in the appropriate length assets to guarantee the money will be available when needed. If this is done for all possible lines of business the result will be a smooth cycle with final payments being made with the corresponding deposited money. Having the first moments of assets and liabilities match is the first task. In other words, the mean durations should be equal. In the classical case, the second moment of the assets should be greater than the second moment of the liabilities. In other theories, mainly the Gifford Fong Theory, the goal is to maximize the lower limit of the confidence interval. In either case, the output can guide the investment division as to what investments to make.
Conclusion

The solubility of an insurance company is greatly affected by the actions of the investment department. If they do not invest properly, reserves may have to be dipped into weakening the financial standing of the company. Immunization has recently been developed to help companies steer away from the misfortune of making inadequate investments. As the name suggests, immunization is a process to acquire a high degree of resistance or security against outside threats of danger.

In the insurance industry, the company wants to be immune from shifts, parallel as well as non-parallel, in interest rates of their investments. This can be accomplished through many different techniques of immunization. The aid of high powered computers and different hardware packages can make immunization a relatively easy process that can be accomplished by any size company. The trail has just begun to be blazed. Many new avenues are yet to be pursued in the development of immunization theory.
Footnotes


7 Ibid.


12 Ibid., p. 5.
Bibliography


