CORPORATE PLANNING MODEL DESIGN: COMPUTERIZED SCRATCH PADS

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Abstract

This paper describes a modular approach to the construction of financial planning models.

This paper will describe financial planning model design permitting such flexibility of use that the models become management's financial planning "scratch pads." Moreover, the structure of a model designed according to this philosophy will be described and a global run of the model will be presented. Significant interrelationships between model design, operating environment and programming language will be considered.

The corporate planning model has, in recent years, largely supplanted its pedestrian predecessor, the hand-generated budget. An immediate benefit was the freedom from computational constraints. But of fundamental significance is the possibility of elevating the term "profit-planning" from the level of a neologism to that of a concept. "Profit-planning" is used in the financial planning literature to describe ... thing from preparing budget schedules to select-accounting methods. A significant activity which well-designed planning models permit is the heuristic selection of various investment alternatives so that a myriad of corporate objectives such as planned profits can be more nearly achieved than otherwise. Thus a well-designed model will permit a corporate planner to manipulate the plan almost effortlessly, extracting and inserting segments of operations to determine their effect on the total financial picture.

The majority of planning models have been developed and are still used in the batch mode. It is not surprising that their design has been influenced by the environment in which they have been constructed and used. The typical construction involves a single program (main program) which may call subroutines or may contain all parts of the model within the single program with input and output options provided. A physical problem unrelated to model design, but associated with batch-run models is turnaround time and the physical necessity of handling data cards for each run. In many installations, good turnaround time is a matter of several minutes and typical time is in the hours. If a run is made of the model, and revisions in the financial plan appear to be desirable, then not only must cards for the variables being changed be handled, but all data cards must be rehandled and re-run.

A solution to this problem has been found in the use of time-sharing, but previously unrecognized problems surface with the change in operating environment. These can be attributed to the model structure which, although appropriate for batch-processing mode, appears to be unnecessarily restrictive for a time-sharing environment. The most confining aspect of batch design models is the necessity that each run of the model be a total run, and that output must be specified as a part of the initial input to the model.

The history of the development of a modular, flexible model was that of discovery in stages. A private concern gave the author a corporate planning model to be used for instructional purposes which was designed to run in the batch-mode. While the model had been designed as a structured model into which various firms might adapt their accounting data, it was readily usable for university instruction in financial planning. It was used with some success, but with the previously mentioned problems associated with batch-processing consuming considerable student time. Probably corporate managers would be even more intolerant than students of the time consumption and the start-stop aspects of planning. Since other computer usage in the course was via a time-shared terminal, it seemed that conversion of the model to this mode would assuage student problems in running the model. Turnaround time would be reduced to perhaps twenty minutes. But another problem appeared: If one program was used for the entire model, all variables must be entered for each run of the model, and this would be more onerous than handling cards. For this reason, and in order to simplify the programming by segmenting the task, it was decided that three functions (programs) would be written. The first function would receive input data, the second would perform the calculations, and the third would produce the financial plan. Thus the design of the batch process model and the time shared model is contrasted in Exhibit 1. Note that the batch-processor is holistic in structure while the time-shared model is modular. Another change of substance from the batch to the time-shared model is the change of language, the former being written in FORTRAN and the latter in in APL. Although there were other compelling reasons for the change, it was mandated because (a) the original model was in FORTRAN and APL batch processors are not generally available, and (b) because our time-sharing service provides APL, but not FORTRAN.

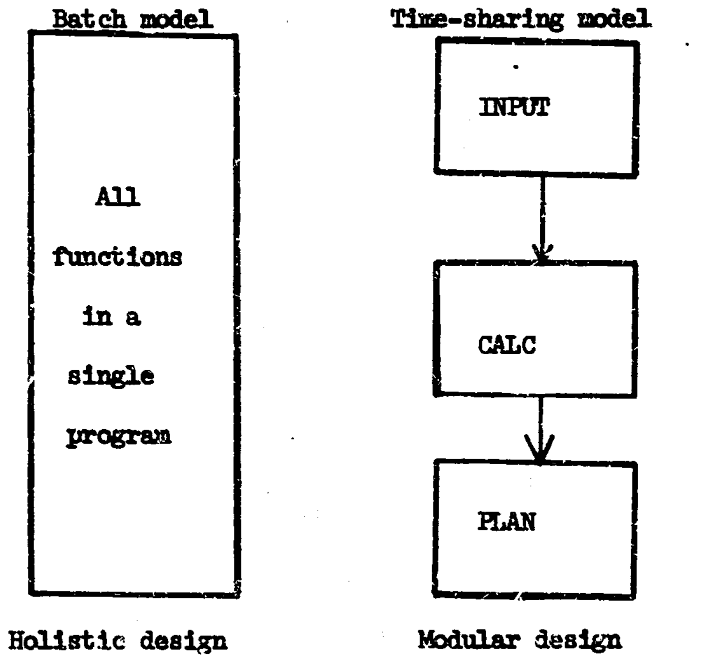

Exhibit 1: Contrasting design characteristics of batch vs. time-sharing models.

BENEFITS DERIVED

Probably the most compelling reason for modular construction of the APL model version was the simplicity in writing functions and debugging them. However, it was discovered that after an initial run of the functions INPUT, CALC, and PLAN, one could then change several input variables most easily by simply redefining them rather than by using the INPUT function again. Then the CALC function could be run and the entire revised plan could be reproduced without requiring use of the lengthy INPUT function. Moreover, if in the initial run of the plan, some one or two output variables appeared to be critical and the additional run was to determine the effect on the critical output variables of changing certain input variables, the entire plan need not be reproduced. Rather, after running the CALC function, given output variables could be obtained by typing the names of the variables. Thus operation of the model was further developed as indicated in Exhibit 2.

At this point design characteristics permitted the model to be used as a "scratch pad" upon which a planning manager could enter incremental changes and view the effects on selected variables in seconds. Typical use of the model in solving financial planning cases was to make an initial run through the model, to examine the plan produced and consider input variables which might be changed to reflect additional investment proposals or asset redeployments. These variable changes were entered individually, CALC was typed and then selected output variables were inspected. Once a number of changes had been made or the plan appeared to be acceptable in respect to the few variables inspected, the total plan would be produced by typing PLAN.

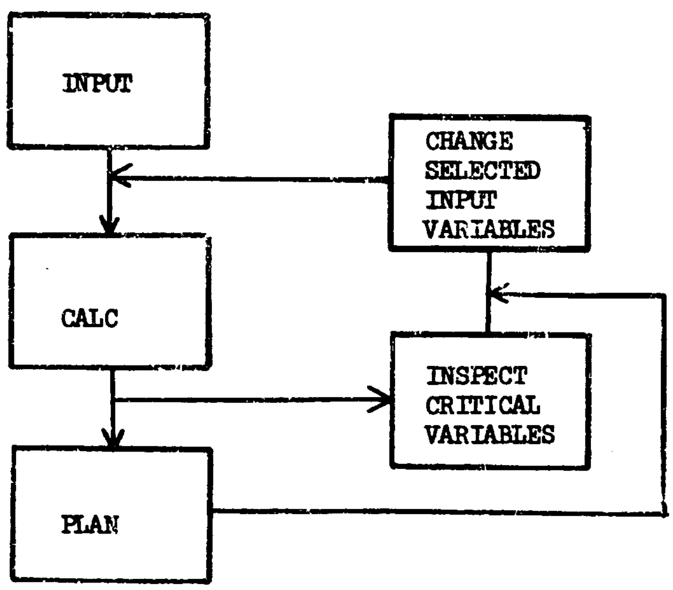

Exhibit 2: Diagram of model operation with modular construction.

The sequence of steps is illustrated on the immediate following pages. The INPUT, CALC, and PLAN functions (programs) are executed in that order; a line has been drawn between each function run for the convenience of the reader. Typing by the user is indented six spaces with the exception of literal input which begins at the left margin. Computer-controlled typing begins at the left margin except as otherwise programmed. For example the first function is called by typing the name INPUT which is indented. The response is a program inquiry, "NAME OF CO?" Since literal input is required, the terminal requests input at the left margin. In contrast, the next inquiry regarding the number of periods and year is numeric and the terminal indents six spaces to receive the response.

Exhibit 3 is the first run of a three year financial plan. All significant corporate objectives would be met if the plan proposed were realized. However, some additional funds must be obtained (see last current liability item), and

```
      INPUT
NAME OF CO?
BARCO ENTERPRISES, INC.
NO. PERIODS OF OUTPUT AND FIRST YEAR OF OUTPUT?
⎕:
      3 1973
RATIO OF CASH TO SALES?
⎕:
      .04
MARKETABLE SECURITIES?
⎕:
      5000
YIELD ON MARKETABLE SECURITIES?
⎕:
      .05
RATIO OF ACC REC TO SALES?
⎕:
      .09
BEGIN RAW MAT OF 1ST PERIOD?
⎕:
      0
RAW MAT TURNOVER?
⎕:
      4
TURNOVER OF WIP?
⎕:
      18
DEGREE COMPLETION WIP?
⎕:
      .5
BEGIN INV OF FIN GOODS (1ST PERIOD ONLY)?
⎕:
      0
TURNOVER OF FIN GOODS INV?
⎕:
      10 12 12
PREPAID EXP/SALES(N+1)?
⎕:
      .02
```

Exhibit 3: Illustration of a run of the principal functions.

```
OTHER ASSETS?
⎕:
      5400
PLANT AND EQUIP?
⎕:
      300000 300000 500000
BEGIN BAL OF ACCUM DEPR?
⎕:
      0
DEPR RATE?
⎕:
      .075
LAND?
⎕:
      20000
DEFERRED CHGS?
⎕:
      2400
ACCTS PAY/MAT. PUR. ?
⎕:
      .12
DIVIDENDS PAY/DIV DECLARED?
⎕:
      .08
DIV PAYOUT RATE
⎕:
      0 0 .3
WAGES PAY/DIRECT LABOR COST?
⎕:
      .05
TAXES PAYABLE?
⎕:
      1000 1000 1500
SHORT TERM LOANS?
⎕:
      35000 35000 10000
INT RATE ON ST NOTES?
⎕:
      .09
LONGTERM DEBT MATURING WITHIN 1 YEAR?
⎕:
      0 0 5000
DEFERRED TAXES?
⎕:
      0 0 4000
LONG TERM DEBT?
⎕:
      0 0 45000
INT RATE ON LT NOTES?
⎕:
      .06
COMMON STOCK SHARES ISSUED?
⎕:
      2500
PAR VALUE COMMON SHARE?
⎕:
      10
PREMIUM ON STOCK BALANCE(S)?
⎕:
      20000
BEGIN RETAINED EARNINGS?
⎕:
      0
YOU MAY ENTER AFIRST PERIOD SALES AMT. AND A GROWTH RATE OR
YOU MAY ENTER ABSOLUTE VALUES.
```

```
DO YOU WISH TO USE A GROWTH RATE?
NO
ENTER SALES VALUES FOR PERIODS OF OUTPUT DESIRED + ONE
□:
      50000 100000 225000 280000
COST OF SALES/SALES? ENTER EITHER A SINGLE VALUE OR
VALUES FOR NO. YEARS OUTPUT DESIRED + ONE.
□:
      .6 .55 .5 .5
DIRECT LABOR COST/COST OF GOODS COMPLETED?
□:
      .4
MATERIAL COST/COST OF GOODS COMPLETED?
□:
      .25
OVERHEAD/COST GOODS COMPLETED?
□:
      .35
FIXED INDIRECT LABOR?
□:
      8000 8000 17000
OTHER OUT OF POCKET FIXED OVERHEAD?
□:
      5000
VARIABLE OVERHEAD/DIRECT LABOR COST?
□:
      .3
VARIABLEADMINISTRATIVE EXP/   SALES?
□:
      .04
FIXED ADMIN EXP?
□:
      5000 10000 20000
VARIABLE SALES EXP/SALES?
□:
      .06 .06 .05
FIXED SELLING EXPENSE?
□:
      5000 10000 25000
EXTRAORDINARY GAINS?
□:
      0 0 2000
EXTRAORDINARY LOSSES?
□:
      0 4300 0
END OF INPUT REQUIREMENTS
TO PROCEED, TYPE 'CALC'
```

```
      CALC
CALCULATIONS ARE BEGINNING, PLEASE STAND BY.
CALCULATIONS COMPLETED.
TO PRODUCE THE COMPLETED PLAN,TYPE PLAN
```

```
      PLAN
TO CENTER OUTPUT VERTICALLYON THE PAGE, ROLL THE PAPER
FORWARDTOA NEW PAGE AND THEN PRESSTHE RETURN KEY.  IF
CENTERING IS NOT DESIRED, SIMPLY PRESS THE RETURN KEY.
```

Exhibit 3: Continued

BARCO ENTERPRISES, INC.
BALANCE SHEET
FOR YEAR ENDS

	1973	1974	1975
CURRENT ASSETS			
CASH	4,000	9,000	11,200
MARKETABLE SECURITIES	5,000	5,000	8,126
ACCOUNTS RECEIVABLE	4,500	9,000	20,250
RAW MATERIALS	3,438	7,031	8,750
WORK IN PROCESS	986	1,635	3,189
FINISHED GOODS	5,500	9,375	11,666
PREPAID EXPENSES	2,000	4,500	5,600
TOTAL CURRENT	25,424	45,542	68,781
FIXED ASSETS			
PLANT AND EQUIPMENT	30,000	30,000	50,000
LESS ACCDEPR.	2,250	4,500	8,250
LAND	20,000	20,000	20,000
TOTAL FIXED	47,750	45,500	61,750
OTHER ASSETS	5,400	5,400	5,400
DEFERRED CHARGES	2,400	2,400	2,400
TOTAL ASSETS	80,974	98,842	138,331
CURRENT LIABILITIES			
ACCOUNTSPAYABLE	1,478	2,198	3,650
DIVIDENDS PAYABLE			733
WAGES PAYABLE	710	1,178	2,296
ACCRUED TAXES	1,000	1,000	1,500
SHORT TERM LOANS	35,000	35,000	10,000
LT DEBT MATURING			5,000
FUNDS NEEDED	2,771	14,700	
TOTAL CURRENT	40,959	54,075	23,179
LONG TERM LIABILITIES			
LONG TERM DEBT			45,000
DEFERRED TAXES			4,000
TOTAL LIABILITIES	40,959	54,075	72,179
STOCKHOLDERS EQUITY			
COMMON STOCK	25,000	25,000	25,000
PREMIUM ON STOCK	20,000	20,000	20,000
RETAINED EARNINGS	-4,985	-234	21,152
TOTAL DEBT+EQUITY	80,974	98,842	138,331

Exhibit 3: Continued

there is some concern that the company may have difficulty placing the long-term debt to be issued during 1975, given the low current ratios for 1973 and 1974. Consequently, a proposal to lease $20,000 of the equipment during 1973 and 1974 rather than purchasing it is being considered. The leasing cost will be $6,000 the first year and $5,000 the second. New equipment will then be purchased in the third year. By leasing equipment, short term loans required in 1973 can be reduced and the necessary additional funds for 1974 are less. Since additional funds must be

BARCO ENTERPRISES, INC.
INCOME STATEMENT
FOR THEFISCAL YEARS

	1973	1974	1975
SALES	50,000	100,000	225,000
COST OF GOODS SOLD	30,000	55,000	112,500
STD GROSS PROFIT	20,000	45,000	112,500
OVERHEAD VARI.	7,085	1,709	¯652
ADJ. GROSS PROFIT	12,915	43,291	113,152
OPERATING EXPENSES			
VARIABLE ADMIN. EXP	2,000	4,000	9,000
FIXED ADMIN. EXP	5,000	10,000	20,000
VARIABLE SELLING EXP	3,000	6,000	11,250
FIXED SELLING EXP	5,000	10,000	25,000
OPERATING INCOME	¯2,085	13,291	47,902
INTEREST EXPENSE	3,150	3,150	3,900
INVESTMENT INCOME	250	250	250
EXTRAORDINARY ITEMS			
EXTRAORDINARY GAINS			2,000
EXTRAORDINARY LOSSES		4,300	
INCOME BEFORE TAX	¯4,985	6,091	46,252
FED. INCOME TAX		1,340	15,701
NET INCOME	¯4,985	4,751	30,551

MANUFACTURING OVERHEAD
FOR THE FISCAL YEARS

	1973	1974	1975
FIXED INDIRECT LABOR	8,000	8,000	17,000
OTHER FIXED OVERHEAD	5,000	5,000	5,000
DEPRECIATION	2,250	2,250	3,750
VARIABLE OVERHEAD	4,260	7,065	13,775
TOTAL ACTUAL OH	19,510	22,315	39,525
OVERHEAD APPLIED	12,425	20,606	40,177
UNDER ¯OVER APPLIED	7,085	1,709	¯652

Exhibit 3: Concluded

secured for the second year, management is also considering the issuance of more shares in 1973. The planner then "scratch-computed" by first considering the effect of leasing equipment and reducing short-term debt, and then calculating the additional shares required to cover the funds deficit. The steps as illustrated in Exhibit 4 are:

1. Redefine the values for plant and equipment, other fixed overhead, and short term loans.
2. Compute new plan values using CALC.

```
      PLTEQ←10000 10000 50000
      OPIXOH←11000 10000 5000
      STLOANS←15000 15000 10000

      CALC
CALCULATIONS ARE BEGINNING, PLEASE STAND BY.
CALCULATIONS COMPLETED.
TO PRODUCE THE COMPLETED PLAN, TYPE PLAN

      TCA÷TCL
1.010533173  1.108029534  2.424549529
      FUNDNEED
6971.111111  21726.49167  3900.321407
      NI
¯7685  3425.175  30551.08333

      CSNO←CSNO+500
      PRECS←PRECS+8×500

      CALC
CALCULATIONS ARE BEGINNING,PLEASESTAND BY.
CALCULATIONS COMPLETED.
TO PRODUCE THE COMPLETED PLAN, TYPE PLAN

      FUNDNEED
0  12726.49167  0
      TCA÷TCL
1.509415808  1.418677585  3.052539434

      STLOANS[2]←STLOANS[2]+13000

      CALC
CALCULATIONS ARE BEGINNING, PLEASE STAND BY.
CALCULATIONS COMPLETED.
TO PRODUCE THE COMPLETED PLAN, TYPE PLAN

      FUNDNEED
0  539.0916667  0
      TCA÷TCL
1.509415808  1.379461447  3.01316769
      MKTSC
7028.888889  5000  9187.068593

      STLOANS[3]←STLOANS[3]-4000
```

Exhibit 4: Illustration of the "scratch pad" characteristics of the time-sharing model.

3. Inspect some critical variables - current ratio (total current assets divided by total current liabilities), net income, and funds needed.
4. Redefine values for common stock and premium.
5. Compute new plan values using CALC.
6. Inspect the critical variables.
7. Continue until acceptable variables appear.

When the user is satisfied that the critical variables are satisfactory, he will then proceed to production of the entire plan for perusal. Note that the turnaround time is governed by the rapidity of the user's mental processes rather than by model constraints since run time for CALC is usually equal to the time required for the typewriter to type the messages involved. The

```
     STORE
PLAN OUTPUT IS STORED

     ARSALE←.09 .15 .15
     SALES←50000 120000 265000 330000
     VADEXPSAL←.04 .05 .05

     CALC
CALCULATIONS ARE BEGINNING, PLEASE STAND BY.
CALCULATIONS COMPLETED.
TO PRODUCE THE COMPLETED PLAN, TYPE PLAN

     PLANDIF
TO CENTER OUTPUT VERTICALLY ON THE PAGE,ROLL THE PAPER
FORWARD TO A NEW PAGE AND THEN PRESS THE RETURN KEY.  IF
CENTERING IS NOT DESIRED, SIMPLY PRESS THE RETURN KEY.
```

BARCO ENTERPRISES, INC.
BALANCE SHEET
FOR YEAR ENDS

	1973	1974	1975
CURRENT ASSETS			
CASH	800	1,600	2,000
MARKETABLE SECURITIES			-3,126
ACCOUNTS RECEIVABLE		9,000	19,500
RAW MATERIALS	688	1,250	1,563
WORK IN PROCESS	31	321	567
FINISHED GOODS	1,100	1,667	2,083
PREPAID EXPENSES	400	800	1,000
TOTAL CURRENT	3,018	14,638	23,587
FIXED ASSETS			
PLANT AND EQUIPMENT			
LESS ACC DEPR.			
LAND			
TOTAL FIXED			
OTHER ASSETS			
DEFERRED CHARGES			
TOTAL ASSETS	3,018	14,638	23,587

Exhibit 5: Illustration of STORE and PLANDIF functions permitting the difference between two plans to be produced.

messages were added since response time may be up to ten seconds if many users are on the system, and students, being accustomed to faster responses, were reassured by them.

Some additional modules have been added to the model and other additions are anticipated. Two functions have been added which permit the user to store the results of the current run, to make changes in variables and make a second run. Then the second run can be produced and/or the differences between the first and second runs can be produced (the plan production will have positive and negative values representing changes between the successive plans). This feature is illustrated by Exhibit 5. Another set of modules permit the user to specify certain financial goals

```
        GOALS
ENTER THE UPPER LIMIT FOR THE CURRENT RATIO
⎕:
        2.3
ENTER THE LOWER LIMIT FOR THE CURRENT RATIO
⎕:
        1.2
ENTER THE UPPER LIMIT FOR THE DEBT/EQUITY RATIO
⎕:
        .5
ENTER THE LOWER LIMIT FOR THE DEBT/EQUITY RATIO
⎕:
        .2 .2 .35
ENTER THE TARGET PROFIT ON SALES DOLLAR
⎕:
        ¯.1 0 .1
TARGET ASSET TURNOVER
⎕:
        .8 1.2 1.5
TARGET EARNINGS PER SHARE
⎕:
        ¯2 1 5
END OF INPUT FOR GOALS

        GOALVAR

CURRENT RATIO GREATER THAN UPPER LIMIT IN 1975 BY 1.1

PROFIT ON SALES DOLLAR DEVIATED FROM THE TARGET BY
                       ¯0.054  0.025  0.037
FOR THE 3 YEARS RESPECTIVELY

ASSET TURNOVER DEVIATED FROM THE TARGET BY
                       ¯0.025  0.022  0.128
FOR THE 3 YEARS RESPECTIVELY

EARNINGS PER SHARE FELL SHORT OF THE TARGET BY
      0.56  0.16  FOR 1973 1974
EARNINGS PER SHARE EXCEEDED THE TARGET BY
      5.26 FOR 1975

ALL OTHER GOALS WERE ACHIEVED.
```

Exhibit 6: Use of programmed goals to diagnose acceptability of the plan.

such as earnings per share and current ratio and to determine the extent to which these goals have been met. Thus critical variables may be specified in the model and their achievement evaluated with each successive pass through CALC. For some purposes this is a more efficient "scratch pad" approach than the informal inspection of individual output variables. The operation of this set of functions is illustrated in Exhibit 6.

The expanded planning model and the alternative use choices give the user maximum flexibility in that he may:

1. Proceed straight through the basic three functions, INPUT, CALC, and PLAN.
2. Input the basic data, perform calculations, inspect critical variables, and either recycle or produce the plan.
3. Input data, perform calculations, input goals, and then examine goal achievement, followed by a recycle or plan

production.

4. Input data, perform calculations, store the plan, recycle by changing input variables, performing calculations, and then determining the differences between the first and second run of the plan.

There are other variations of course, with this variety essentially giving management a powerful scratch pad for planning financial operations.

Several other features can be conveniently added due to the modular construction. RESTORE, a function which restores a stored plan so that it can be produced can be easily added. In fact, a series of store and restore functions can be created and distinguished by adding 1,2, or 3 to the function name. The successive runs of the plan could be retained within the same workspace for future use or reference. (In many instances it will be more convenient to save the results of a run in a separate workspace.) A function called QUARTERS would convert annual values (such as interest rates and programmed fixed costs) to quarterly values, thereby permitting the generation of plans by quarters in addition to years. Some additional segmentation of the existing functions may be necessary to accomplish this, but the concept should be transparent.

THE RELATIVE MERITS OF APL

Although other languages are available via time-sharing, APL possesses several characteristics which recommend it for use. Some of these are the extension of arithmetic operations to vectors on an element by element basis and the ability to mix integers and vectors. This ability eliminates the necessity for loops when combined with the use of certain primitive functions such as take (↑) and drop (↓) which are useful in accomodating lead and lag relationships. Moreover, subscripting of variables is unnecessary. In the model, for example, cash at the end of a fiscal period is assumed to be a function of the following year's sales. The program statements in FORTRAN and APL are compared below:

FORTRAN:

```
DO 205, I=1,NOYRS
CASH (I) = RCASSAL(I)*SALES(I+1)
```

APL: *CSH←RCSHSALE×¯PERIOD↑SALES*

Of course the 'DO' loop encompasses variables other than cash. But it should be noted that while several loops are required in FORTRAN, none are required in the APL version of the model due to the structure of the language.

Another significant advantage of APL is that no dimension statements are required; in contrast, the FORTRAN version of the model required fourteen lines of such statements. Output formatting is also simpler.

FORTRAN:

```
WRITE(108,2040) (CASH(I), I=1,NOYRS)
2040 FORMAT ($CASH$,16X,F8.0,4(3X,F8.0))
```

APL: *'CASH   ','BCI14' ΔFMT CSH*

The lack of dimensioning in APL means that the model can operate on one, five, twenty, fifty year projections, while the FORTRAN model is constrained to a five year projection. The formatted plan output in either case is limited to the width of the printing device.

CONCLUSIONS

The conversion from hand-generated financial budgets to computerized planning models was a significant step in the development of corporate management. The concept of multiple cuts of the budget became a reality rather than a step resorted to on a partial basis or only in the most extreme situations. The holistic design of such early planning models was appropriate for the batch operating environment.

But with the availability and use of time-sharing, design characteristics should recognize and capitalize on changes in the operating environment. While some have called attention to desirable characteristics of models, it is also important to recognize interrelationships between the operating environment, model design characteristics, and even the choice of programming language. For example, some have advocated the use of flexible rather than structured models (as the one described here). But flexible models begin to assume the characteristics of a limited programming language, and require more user time than structured models. Thus if one utilizes a concise language (APL) for model construction, the cost of adapting a structured model to unique circumstances may be less than the cost of using (overlooking the greater programming cost) a less powerful language.

A modular-designed corporate planning model such as described here provides management with a scratch pad approach to planning, permitting attention to proposals and their effects rather than distraction by interruptions occasioned by total runs of plans when such is unnecessary. The ability to enter only those variables being changed and to inspect the effects of the changes within five to ten seconds permits the type of concentration being sought for by researchers in computer assisted instruction. When this state is achieved in corporate planning, the computer has become an interactive management tool rather simply a rapid calculator. The difference is qualitative as well as quantitative, since management can do in an appropriately designed interactive environment what cannot be accomplished in a batch oriented environment due to time constraints and limited retention ability of the human mind.