

# PLANCODE Investment analysis

An illustrative introduction  
to business planning and modeling

15				*****	
14				*	*
13			*****		*
12			*	**	*
11	+++++	+++++	+++++	+++++	+++++
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1	++	++	++	++	+
0	*****	++	++	++	+
	1	2	3	4	5



**As a business planner said:**

'How can I foresee the future development of an investment project? Well, I can estimate sales and costs et cetera - but what does that give me? There are more 'what-if' questions than I can answer in time to find the best alternative of a project. What if the estimated fixed and variable costs will increase? What if a better cash flow can be obtained, but with higher raw material costs? What if forecasted sales are not reached? And secondly, after having decided on one project, how to identify critical factors which cause big effects by little changes in their value? How far can sales go down before the profitability limit is reached? And what if...



## A rational approach to planning

In today's complex and highly inter-related business environment, planning is a formal process rather than an intuitive guessing game. Decisions are to be based on facts. Consequently, before a decision is made on whether to go ahead with one of the projects, Management wants to see a plan showing the cash flow over the life of the investment, a financial model of the project during its life time.

In order to calculate the model with given data (and possibly one or two alternatives), paper, pencil, and a pocket calculator are required - and some patience - and a recalculation step to make sure that no errors have been made. And another recalculation if some assumptions change. And . . .

Why not use a computer? Provided that the same, familiar way of expressing the dependencies can be used, that no knowledge of computer internals is required.

## Investment model

Computerized business models frequently had the image of being very difficult, sophisticated, and too complicated to be understood by management. That's not true nowadays: the relationships and dependencies in a model can be developed as in a normal discussion, and the formalized expressions to be communicated to the computer are no more complicated than school arithmetic.

In order to perform the calculations in our example of an investment model, the following values are given and will remain unchanged from year to year:

- the discount rate to be applied to the present value calculations is 16%
- the amount of the initial investment is 50,000,000 dollars
- the salvage value of the investment is 500,000 dollars

The project applies to an investment in the manufacturing of three alternative products, named: RED, BLUE, and GREEN.

*This is the desired result of a computerized investment model: a simple graph showing key results, e.g., the Cumulative Present Value of the investment.*



```

INVESTMENT PROJECT B L U E
15 |
14 |
13 |
12 |
11 | +-----+
10 | +         ++         ++         ++         ++         +
 9 | +         ++         +-----+         ++         +
 8 | +         ++         ++         ++         ++         +
 7 | +         ++         ++         ++         ++         +
 6 | +         ++         ++         ++         ++         +
 5 | +         ++         ++         ++         ++         +
 4 | +         +-----+         ++         ++         +
 3 | +         ++         ++         ++         ++         +
 2 | +         ++         ++         ++         ++         +
 1 | +         ++         ++         ++         ++         +
 0 | +-----+         ++         +-----+         +-----+
    |         1         2         3         4         5
BASE = 12019.48   UNIT = 3345.81
CUM_PRES_VAL= *   CUM_INV= +
  
```

## The dependencies in the model

The cash inflows for the project are generated from sales revenue. The revenue is calculated from Sales Units and Unit Price, estimated for each year of the project life (Sales are in 1000s, therefore all money terms in K\$). Also estimated are the costs of running the project (the cash outflows), namely Labour, Manufacturing, Marketing, and Raw Material. The latter two have a fixed part and a variable part which is dependent on the sales figures in a way which is given below. The Net Cash Flow Before Tax (N.C.F.B.T.) is simply the difference between cash inflows and cash outflows before payment of current taxes due.

Depreciation of the initial outlay (considering the salvage value) is calculated on a straight line basis, and Tax is accounted for only if the N.C.F.B.T. less Depreciation is a positive figure. The effective tax rate is 42 percent.

The Net Cash Flow After Tax (N.C.F.A.T.) in any year is to be assessed as the N.C.F.B.T. less Tax (plus, in the last year, the Salvage value of the investment).

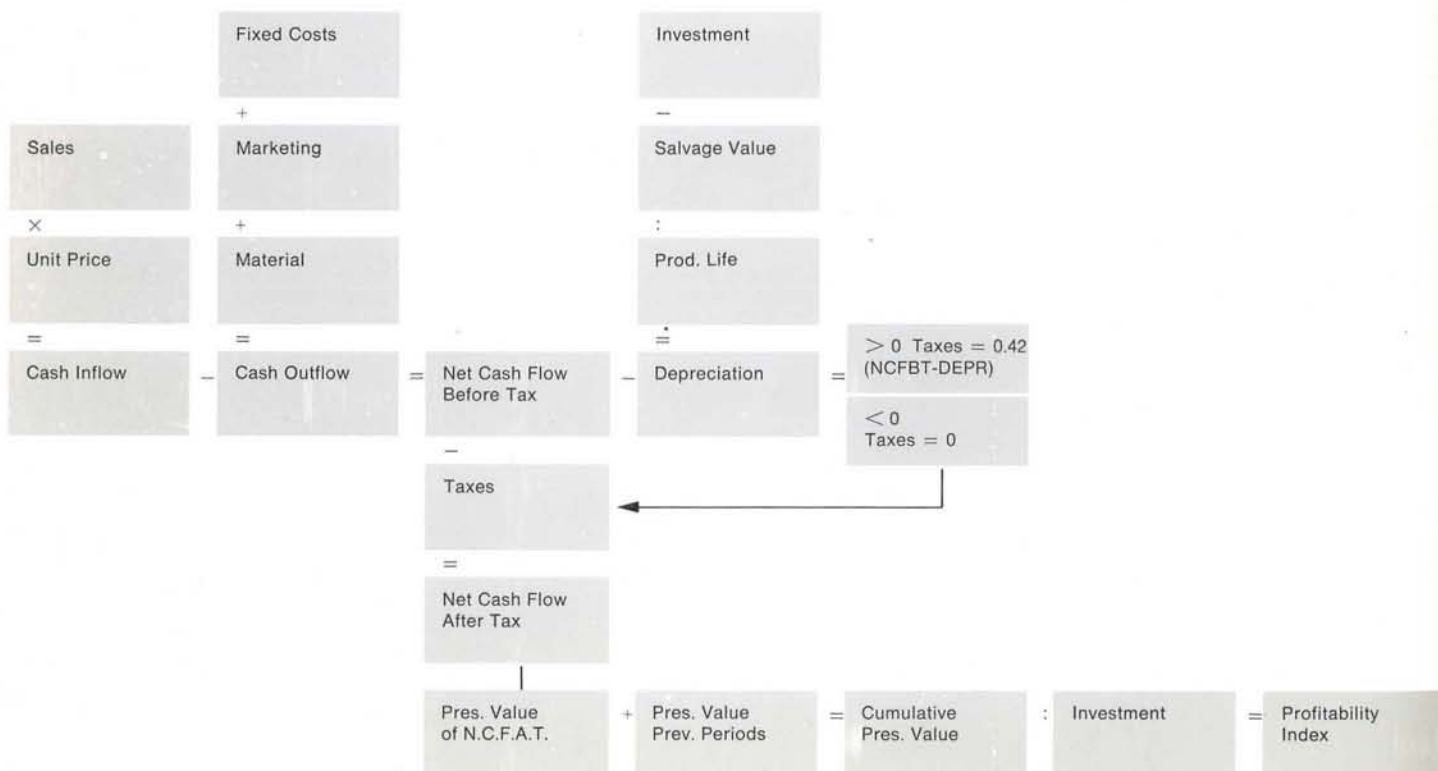
The Present Value (P.V.) of the N.C.F.A.T. is to be calculated using the discount rate supplied above, and accumulated over the years.

The cumulative P.V. is used to arrive at a Profitability Index for the whole project. This is the ratio of the Cum. P.V. to the Initial Investment; and it will be used to judge the overall worth of the project.

## Modeling with PLANCODE

'PLANCODE' is the short name for the IBM Program Product 'Planning, Control, and Decision Evaluation System' which is a generally usable tool for many Business Management applications. The interactive component of it, PLANCODE/Interactive, is particularly suited for the direct man-computer interaction via a display terminal.

PLANCODE uses a 'modeling language' as closely related as possible to the way financial dependencies are expressed. Only a minimum of rules has to be followed, e.g., that names have to be one string of characters - therefore 'UNIT PRICE' is concatenated with the underscore character to become 'UNIT\_PRICE'. The dependencies as described before are now formalized and then written in the PLANCODE modeling language.



## Verbal

Cash Inflow is Sales (Units of 1000) times Unit Price.

Fixed Costs are the sum of Labour, Manufacturing, and fixed part of Marketing/Manufacturing.

Variable Marketing Costs are 23 dollars per unit sold.

Variable Material Costs are 27.5 dollars per unit produced (i.e. sold).

Cash Outflow is the sum of all costs (fixed and variable).

Net Cash Flow Before Tax is Cash Inflow minus Outflow.

Depreciation (straight-line) is Initial Investment minus Salvage value, divided by Product Life (P.L.).

If Net Cash Flow Before Tax is bigger than the Depreciation, calculate Taxes to be paid at 42 percent tax rate on the difference between both items.

Net Cash Flow After Tax is the one before tax, minus taxes; with the salvage value added in the last year (Product Life end).

Present Value is Net Cash Flow After Tax in every year, discounted (with the rate of 16 percent) to its actual value in the present year - a common financial operation for which, e.g., tables can be used.

Cumulate Present Value over the years: if one goes along the years (columns), Cum. P.V. is current P.V. plus Cum. P.V. of previous year (except for first year).

Profitability Index (P.I.) is Cumulative Present Value at the end of Product's life divided by the initial Investment.



\* ASTERISK LINES ARE COMMENTS  
 INPUT FILE = RED  
 \* FILE NAME CAN BE MODIFIED TO 'GREEN' OR 'BLUE'  
 \* FOLLOWING STATEMENTS EXECUTED FOR ALL COLUMNS AT ONCE

Verbal	Formalized	PLANCODE
Cash Inflow is Sales (Units of 1000) times Unit Price.	CASH INFLOW = SALES * UNIT PRICE	CASH_INFLOW = SALES * UNIT_PRICE
Fixed Costs are the sum of Labour, Manufacturing, and fixed part of Marketing/Manufacturing.	FIXED COSTS = LABOR + MANUFACTURING + FIXED M./M.	FIXED_COSTS = LABOR_COST + MANUF_COST + FIXED_MM
Variable Marketing Costs are 23 dollars per unit sold.	MARKETING = 23 * SALES	MARKETING = 23 * SALES
Variable Material Costs are 27.5 dollars per unit produced (i.e. sold).	MATERIAL = 27.5 * SALES	MATERIAL = 27.5 * SALES
Cash Outflow is the sum of all costs (fixed and variable).	CASH OUTFLOW = FIXED COSTS + MARKETING + MATERIAL	CASH_OUTFLOW = FIXED_COSTS + MARKETING + MATERIAL
Net Cash Flow Before Tax is Cash Inflow minus Outflow.	N.C.F.B.T. = CASH INFLOW — CASH OUTFLOW	N_C_F_B_T = CASH_INFLOW — CASH_OUTFLOW
Depreciation (straight-line) is Initial Investment minus Salvage value, divided by Product Life (P.L.).	DEPRECIATION = (INVESTMENT — SALVAGE) / P.L.	* PROJECT LIFE 'P_L' IS PLANCODE-INTERNAL NAME 'MXK' P_L = MXK * INV = INVESTMENT, SAL = SALVAGE VALUE INV = 50000 SAL = 500 DEPRECIATION = (INV — SAL) / P_L
If Net Cash Flow Before Tax is bigger than the Depreciation, calculate Taxes to be paid at 42 percent tax rate on the difference between both items.	IF N.C.F.B.T. > DEPRECIATION THEN TAXES = 0.42 * (N.C.F.B.T. — DEPRECIATION)	IF N_C_F_B_T > DEPRECIATION THEN TAXES = 0.42 * (N_C_F_B_T — DEPRECIATION)
Net Cash Flow After Tax is the one before tax, minus taxes; with the salvage value added in the last year (Product Life end).	N.C.F.A.T. = N.C.F.B.T. — TAXES N.C.F.A.T. (at P.L.) = its value + SALVAGE	N_C_F_A_T = N_C_F_B_T — TAXES * N_C_F_A_T CORRECTION FOR LAST YEAR N_C_F_A_T (P_L) = N_C_F_A_T (P_L) + SAL * 'ACTUAL' FINANCIAL CALCULATION ROUTINE BUILT INTO PLANCODE
Present Value is Net Cash Flow After Tax in every year, discounted (with the rate of 16 percent) to its actual value in the present year - a common financial operation for which, e.g., tables can be used.	LOOK UP ACTUAL (0.16, N.C.F.A.T., giving PRES. VAL.)	CALL ACTUAL (0.16, N_C_F_A_T, PRES_VAL)
Cumulate Present Value over the years: if one goes along the years (columns), Cum. P.V. is current P.V. plus Cum. P.V. of previous year (except for first year).	CUM. P.V. = PRES. VAL. for first year CUM. P.V. = PRES. VAL. + CUM. P.V. (prev. period) for following years	CUM_P_V (1) = PRES_VAL (1) * FOLL. STATEMENT AUTOMATICALLY NOT EXECUTED * IF REFERRING TO PERIOD 0 (\$1 MEANS 'PREVIOUS') CUM_P_V = PRES_VAL + CUM_P_V\$1
Profitability Index (P.I.) is Cumulative Present Value at the end of Product's life divided by the initial Investment.	P.I. = CUM. PRES. VAL. (P.L.) / INVESTMENT	* P_J = PROFITABILITY INDEX P_I = CUM_P_V (P_L) / INV

These 'Modeling Statements' are typed in directly at the terminal, automatically checked for correctness, and stored in PLANCODE for later

execution. Through all these steps, the user is guided by PLANCODE input request messages and explanations.

## The heart of PLANCODE

The heart of the PLANCODE system is a table with rows (line items) and columns (normally planning periods, e.g. years) like the planning table sketched on a writing pad. A single, user-assigned name refers to line items in the table, referring to all their column values - that is, in a 5-years (5 columns) plan, the name 'SALES' refers to all the values for 5 years' sales figures. To distinguish single-value items ('parameters') from line items of the table, names with 1-3 characters are used. Therefore, 'INV = 50000' sets the one-value parameter INVESTment to 50,000.



	PROJECT R E D				
	1976	1977	1978	1979	1980
UNIT_PRICE	140.00	160.00	175.00	190.00	205.00
SALES	110.00	175.00	220.00	195.00	180.00
CASH INFLOW (K\$)	15400.00	28000.00	38500.00	37050.00	36900.00
FIXED_COSTS	1425.00	1205.00	1080.00	1010.00	1080.00
VAR. MARKETING COSTS	2530.00	4025.00	5060.00	4485.00	4140.00
VAR. MATERIAL COSTS	3025.00	4812.50	6050.00	5362.50	4950.00
CASH OUTFLOW (K\$)	6980.00	10042.50	12190.00	10857.50	10170.00
NET CASHFLOW BEF TAX	8420.00	17957.50	26310.00	26192.50	26730.00
DEPRECIATION	9900.00	9900.00	9900.00	9900.00	9900.00
TAXES		3384.15	6692.20	6842.85	7068.60
NET CASHFLOW AFT TAX	8420.00	14573.35	19417.80	19349.65	20161.40
CUMULAT. PRES. VAL.	7258.62	18088.99	30529.16	41215.80	50814.90
PROFITABILITY INDEX	1.016				
	+++++	+++++	+++++	+++++	+++++

## First modeling results

With the modeling logic shown above - simple arithmetic statements - and the data (assumptions) provided by the responsible departments (which are stored into a PLANCODE file), we can evaluate the Investment Plan for the Product RED.

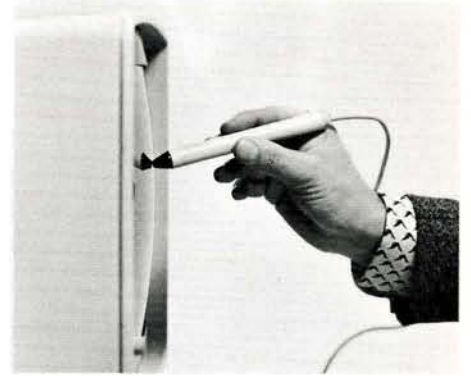
Over the projected life time, 5 years, we reach a Cumulative Present Value of about 50.8 Million Dollars which, compared to the initial Investment of 50 Million Dollars, yields a Profitability Index of 1.016 - a value which in light of the uncertainties in the assumptions about the future figures is not too reassuring.

A report with user-supplied print specifications shows the calculation results in proper layout (see image on this page).

Another product that can be produced with the proposed plant (i.e. the same investment), is named GREEN. Compared to RED, it has a higher sales forecast (but dropping faster towards plan end), a more stable price, same Labour and Manufacturing Costs, and about  $\frac{1}{2}$  to  $\frac{1}{3}$  of the Fixed Marketing and Material Costs. A recalculation of the model shows a Profitability Index of 1.13.

The third possibility is BLUE, on the cost side similar to RED, also for the price. The sales curve looks like GREEN, but with a flatter peak. Calculations show that it is the most profitable project: Index 1.24. A consolidated report on the investment alternatives shows the key figures for the three projects. That ends the Project Selection process. Is the trouble of making the right decision over now?

Basis of the results are data where certain assumptions about the future are made: Sales, Cost, etc. These assumptions bring uncertainties into our model.



MANAGEMENT SUMMARY REPORT					
	1976	1977	1978	1979	1980
CUMULATIVE PRESENT VALUES: 3 CHOICES					
PROJECT RED	7258.62	18088.99	30529.16	41215.80	50814.90
PROJECT GREEN	11041.98	24160.07	38959.78	49998.78	56666.60
PROJECT BLUE	12019.48	25370.33	41257.84	54404.60	62206.69
PROFITABILITY INDEX					
	RED	GREEN	BLUE		
	1.016	1.133	1.244		
*****					
NOVEMBER	02	1975	*** CONFIDENTIAL ***		



## Productive model usage: 'What if...'

Productive use of computing power, once the model and data are stored in the machine, is the thorough evaluation of different assumptions and alternatives in order to judge the uncertainties involved:

- what if assumed Sales cannot be reached?
- what if Material Costs go up drastically.
- what if also estimated model parameters (such as Marketing Dollars per Unit) change?
- what if the modeling logic has to be modified (e.g. Material Costs depending on, besides Sales, a Material Cost Index)?
- what if product life is only 4 years?

These assumptions, once assessed by the planning analyst, can easily be evaluated by the machine. It's called 'Sensitivity Analysis' or 'What-if Technique' - to identify the critical values, where little changes possibly cause big effects. The results can immediately be seen at the terminal, where the question-and-answer session between the user and PLAN-CODE takes place (PLANCODE requests identified by 3-digit number). Here are some possible steps a planner might go through:

- 1 Perform a Sensitivity Analysis on the Profitability Index depending on Sales: Sales to be varied by -10 percent in 3 iteration steps. Results show that the Profitability Index decreases slightly less than 10 percent and that the break-even point is about 76 percent of the originally projected Sales figures.
- 2 Worst assumptions for the data item 'Fixed Marketing/Material Cost' resulting in a 1980 figure to be 53 percent higher than the original assumption must have an impact on the profitability. However, this impact on the (rounded) Profitability Index is minimal.
- 3 Maintaining the high Material Costs of the previous step, the Marketing Cost factor in the model, '23 dollars per 1000 units', is increased 20 percent to 27.6 dollars per unit. The Investment Proposal turns out to be also rather insensitive to that change.
- 4 The modeling logic is modified to test the possibility that the variable Material Costs, now being 27.5 dollars per unit, are dependent on time; that is, on a Material Cost Index which is 1 in the starting year and raises 25 percent each year. It is also assumed that the old Fixed Marketing/Material Costs apply again. This possible development shows some impact on

the Cash Outflow and brings the Profitability Index down from its original 1.24 to 1.13.

- 5 Finally, Project BLUE is investigated under the assumptions of Case 1, but a life time of only 4 years. The result shows that the Profitability Index drops to 1.15.

Here the value of the computer really becomes visible: it is not just a calculation tool but a decision support system - the planner formulates his assumptions, alternatives, and hypotheses; the computer supplies him with the results of his actions.

▷ = user input

```

183 INPUT MODEL NAME(OR 'LAST' COMMAND)
▷ INVESTM

064 INPUT NUMBER OF COLUMNS:
▷ 5

184 INPUT REPORT NAME(OR 'LAST' COMMAND)
▷ INVESTR

120 INPUT PRINT OPTIONS(OR 'LAST' COMMAND)
▷ COL=(1 TO 5),YEAR=1976,ZERO=NO
186 CHANGE DATA?
▷ Y

187 INPUT ROW NAME AND DATA(OR 'LAST' COMMAND)
▷ FIXED_MM 950,900,1130,1220,1350
  
```

	1976	1977	1978	1979	1980
CASH INFLOW (K\$)	26400.00	35700.00	50350.00	47000.00	28350.00
CASH OUTFLOW (K\$)	9530.00	11985.00	14992.50	13497.50	8597.50
NET CASHFLOW BEF TAX	16870.00	23715.00	35357.50	33502.50	19752.50
NET CASHFLOW AFT TAX	13942.60	17912.70	24665.35	23589.45	16114.45
CUMULAT. PRES. VAL.	12019.48	25331.54	41133.58	54161.83	61834.13
PROFITABILITY INDEX	1.237				
	*****	*****	*****	*****	*****



## How the model was constructed

The dependencies described in this example seem to be well known, but are they really? Some of them, of course, are defined by the nature of the business, by the rules of Industrial Management and Economic Theory, by legal and financial laws. Other dependencies might be given by the experience and the judgement of the decision makers, like 'We spend 23 dollars Marketing Costs for every 1000 units sold'. Why not 20 dollars, or 25 dollars? In cases where dependencies are less simple than here, evaluating these parameters by 'rule-of-thumb' methods might not create the required accuracy of the model. Mathematical Methods, e.g. Regression Analysis, are needed to estimate these parameters from observed figures of the past.



Assume that Sales and Marketing Cost figures for the predecessor of BLUE have been observed over the past 10 years and that the assumption that marketing BLUE is done with the same Sales/Cost ratio is valid. The Regression Analysis method, part of the built-in features of PLANCODE, gives us the statistically exact estimate of the Modeling Parameter, 22.42 in our case.

## Reality

A model is an abstraction from reality depicting some of its important characteristics. It can be used to perform tests and experiments which would not be possible otherwise, like the laboratory equipment of a physicist is used for modeling. Modeling is done in steps: proceeding from a very simple model - giving general insight, to a more realistic model to obtain usable results.

Therefore, this simplified investment model would be much more complex in reality, e.g.

- use another depreciation method, e.g. double declining balance, in order to adjust taxes to periods of high/low cash inflow,
- take more variables, more detailed dependencies into account,
- calculate the Net Present Value (NPV) of the investment, or the Internal Rate of Return (IRR) on the investment, rather than the Profitability Index,
- determine critical values for highly uncertain independent variables; for instance the lowest possible SALES figures which still give a positive IRR,

... and so on. If we benefit from having computer support in the simple case, we surely need one in those cases which are much more complex than our little demonstration example.

```

060 INPUT FILE NAME:
▷ HISTORY

079 INPUT VARIABLE NAME TYPE(P/R OR S) ROW NUMBER(S ONLY)
▷ MARKETING_HIST R

205 HOW MANY PERIODS FOR FORECAST?:
▷ 0

214 HOW MANY EXOGEN VARIABLES?:
▷ 1

211 EXOGEN      1          INPUT VARIABLE NAME TYPE ROW NUMBER (SUBMATRIX):
▷ SALES_HIST R
  
```

### MULTIPLE REGRESSION REPORT

	1	2	3	4	5	6
75/12/01						
INITIAL VALUES	2802.00	3504.00	4162.00	4991.00	5837.00	5459.00
FINAL VALUES	2828.31	3545.63	4016.37	5002.69	5832.09	5361.35
EXOGEN 1	125.00	157.00	178.00	222.00	259.00	238.00
INTERCEPT	26.27					
COEFFICIENTS	22.42					
75/12/01						
INITIAL VALUES	4699.00	4272.00	3789.00	3518.00		
FINAL VALUES	4823.36	4307.78	3926.71	3388.72		
EXOGEN 1	214.00	191.00	174.00	150.00		
INTERCEPT						
COEFFICIENTS						

## Other applications

Investment Analysis is but one application. There are other areas in Business Planning which equally benefit from computer-supported 'What if' Techniques.

These applications can be handled by PLANCODE/Interactive if they have two main characteristics:

- they involve a small or moderate amount of data (say, tables not greater than 1500 lines and 60 columns)
- they require a high degree of user interaction (say, a sequence of different analyses).

Interactive Planning and Modeling tools can be applied in many industries and organizations and in many functional areas, such as:

- General Management  
Strategic, Tactical, and Operational Planning  
Budget Planning and Control  
Forecasting
- Financial Management  
Cash Management  
Use and sources of funds  
Loans and capital repayments plan  
Funds flow analysis  
Cost studies
- Marketing  
Product marketing plan  
Pricing analysis  
Sales force incentive plan  
Advertising media analysis  
Distribution channel analysis
- Administrative Management  
Personnel (hiring, salary, and assignment)  
Education plan  
Space evaluation, building plan
- Plant Management  
Capacity study  
Investment in new equipment  
Manufacturing expenses  
Material and Supplies Planning and Control

The second component of PLANCODE, the non-interactive PLANCODE/S, does not have the data size restriction of PLANCODE/I and offers more functions (e.g. Budgeting). It can be used for an even wider range of applications where direct man-computer interaction is not needed.



## Value of computerized business modeling for management

- It establishes an economical and practical mechanism to evaluate many business alternatives. Any business plan involves making assumptions about the future and evaluating the consequences of such assumptions. This evaluation is mostly done by iterating through a variety of alternative possible courses of action - the 'what-if' technique - but the number of iterations required to give a complete picture of the problem can be enormous. Using a computer, compressing the time spent in doing manual calculations, the planner is able to go into greater detail in his planning as well as examine more alternatives, or he can shorten his planning cycle.
- It is often easy to computerize existing methods of planning. The planner can build models by describing his present documents and logic. Even a detailed profit and loss statement, when programmed to allow projections for a number of quarters or years ahead by product line and/or by division or region or any other category, becomes a very useful tool for planning purposes. The same is true of an automated pro forma balance sheet. Frequently, the executive himself will define the kind of planning documents he needs.
- It provides documented assumptions and results. The computerized planning process requires the complete spelling out of the logic used in developing a business plan and thus serves to document the planning logic so that every manager can be assured that his interest is implemented.
- It helps the planner to develop greater understanding of business relations. As the planner will have evaluated



many different cases and documented their planning logic, he is able to examine many business relationships in detail. In this way he is in a better position to build up an overall picture of the business and hence to develop a deeper understanding of these relationships.

- It ensures the internal consistency of all planning segments. Using the same program and assumptions for several or all departments of a company, the results are consistent within the company, and can be consolidated and compared at several levels.
- It helps formalize the planning process. Departments can build individual modules for their requirements, and still retain the ability to incorporate them within the framework of a planning system for the company.
- It helps define information needs. Business Planning can help define data requirements for a management information system and is an inexpensive way to get started. For example, PLANCODE models can help answer questions concerning the data elements that should be in the data base, the format of reports, the questions that the system must be able to answer, the frequency and predictability of report request, the response requirements and degree of interaction required, etc.

Some of these benefits can be quantified in money terms, others not. It is up to the judgement of the decision makers to determine the weight of the qualitative benefits when comparing costs and value of a computer-supported planning system.

## Summary

Even a simple example like this Investment Analysis is suited to show:

- that a model of business dependencies can be constructed in a computer
- that the model is formulated in a language similar to the way the user expresses the dependencies
- that the computer can evaluate different assumptions, hypotheses, scenarios of such a model
- that computer-supported mathematical methods help to find the parameters of the model
- that other applications, not necessarily similar ones, can benefit from the general Business Modeling facilities provided in PLANCODE.

In short, that the computer is an indispensable tool for effective Business Management.

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