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CORPORATE MODELLING FOR SETTING
AND MONITORING INVESTMENT STRATEGY

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Abstract

The paper considers the design of computer-based modelling systems to support corporate management in setting, implementing and monitoring investment strategy. Two successful modelling systems developed for these purposes, taken from a program of field research, are described. The desirable design and implementation features of the systems are discussed, and general conclusions are offered on the basis of these.
There has been considerable interest recently in the design and application of computer-based information systems to support the top management of organizations. Rockart [1979] proposed a method, developed from field experience, for harnessing the computer to top executive monitoring needs. He essentially sets out a design philosophy, based on defining "Critical Success Factors" (CSF's), of placing the individual executive at the center of the information systems development activity. Rockart and Treacy [1982] provide several examples of systems designed to support the monitoring needs of top executives.

In this paper a similar theme is developed, but with two important differences. First, rather than focussing on the monitoring needs of specific executives the emphasis is on supporting a top executive function, namely the financial appraisal of strategy and its implementation through the allocation of financial resources in the organization. Secondly, whereas in the CSF approach managerial decision making is left largely implicit in the design of information systems, in this paper a decision making perspective is explicitly identified. Thus, the paper's theme is closely aligned with the concept of "Decision Support Systems" (DSS), as developed for example by Keen and Scott Morton [1978].

The paper is organized as follows. In the next section the literature on corporate financial modelling is briefly reviewed. This is followed by two sections, each describing a successful modelling approach to supporting aspects of the corporate management of investment strategy. A final section draws some general conclusions based on the two case studies.

CORPORATE FINANCIAL MODELLING

In the early 1970's there appeared to be a fairly widespread view that
corporate strategic modelling had been a failure. Hall [1973], for example, posed the question, "Are top managers finding (strategic planning models) useful?" Based on his study of the use of models in 17 companies in a wide variety of industries he concluded they were not. He traced the reasons for failure to: erroneous assumptions on the part of modellers about the nature of planning; inadequate consideration of how a model should be integrated into the managerial process; a tendency toward normative, assertive modelling rather than less-obtrusive, supportive modelling; simplistic cause-and-effect relationships in models; and isolation of model development from the planning process.

A number of surveys nevertheless indicated a rapid increase during the 1970's in the rate of development and adoption by companies of computer-based corporate financial models (Traenkle et al. [1975], Naylor and Schauland [1976], Grinyer and Wooller [1978]). This seems to suggest that managements have been overcoming the earlier difficulties identified by Hall and are now devising and implementing models which are effectively supporting at least some aspects of corporate decision making.

During the 1960's corporate modelling appeared to be characterised by large detailed simulations of the firm, requiring extensive data bases. A well-known example of this is the model which was developed by the Sun Oil Company, described by Gershefski [1969]. This combined a logistics model of the firm's operations with an accounting model based on the general ledger. Beginning with models of each operating department, the corporate model was derived by a bottom-up hierarchical consolidation following the managerial organization's reporting structure. The model was successfully implemented, but principally in support of operating planning and budgeting rather than corporate strategic planning. It subsequently proved to be inflexible in the face of significant changes in the company's business operations and
organization structure and eventually fell into disuse.

Design philosophy appeared to change during the 1970s. For instance, Lorange and Rockart [1977] proposed a framework for differentiating models in relation to an analysis of the corporate planning and control process. They advocate the development of models tailored to specific purposes, these being loosely coupled within the organization's administrative process. In a similar vein, Carleton et al. [1973] pointed out that the usual form of financial model, the budget compiler, is ill-suited to handling the main issues in the domain of corporate financial strategy. They propose for this type of application a highly aggregated modelling structure, dealing with cash flows and economic measures of value, as well as with the main accounting flows such as earnings and funds, and focusing on the maximization of the cash flows attributable to a unit of corporate ownership. Swanson [1973] also emphasized the importance in models designed to support strategic decision making of concentrating the focus of the model on matters directly pertaining to the decision at hand. This argues for suppressing much of the detailed complexity which characterizes operational decision making in order to cut through to the essence of strategic concerns.

In the realm of corporate investment decisions this can be interpreted to mean a concern with the broad mix and rate of investment of financial resources within the organization. Top management's strategic role is to guide the general thrust of the organization's development (Anthony [1965]) not to be concerned with the operational details of project identification, selection, implementation and control. These latter aspects of investment management should properly be delegated. However, an attendant top management concern is whether the broad direction established in strategy setting is being pursued in the delegated phase.

Two examples of financial modelling are now presented to illustrate
successful approaches to supporting corporate strategic planning and monitoring of investment. They are selected from a program of field research investigating the design and use of computer-based financial models in large companies. The models were judged to be successful because they were used frequently, resources were committed to maintaining them, and their users expressed satisfaction with the model output. Both models come from large integrated oil companies. The first one was developed to assist top management in appraising the rate and mix of investment among the company's businesses. The second one was used to support the planning, authorization and monitoring of strategic investment programs in the organization.

APPRAISING AGGREGATE INVESTMENT STRATEGY

The corporate model described in this section was initially developed and implemented in the period around 1970. Prior to its development the company had experienced a prolonged period of stability in its operations, performance and rate of investment. Corporate management was concerned that the company was not aggressively enhancing its competitive position and future potential.

The company was organized into several subsidiaries, each having operating responsibility in a designated region of the world; another subsidiary was responsible for transportation among the operating subsidiaries. Each operating subsidiary was comprised of three divisions, having responsibility respectively for exploration and production, refining and marketing, and petrochemicals. Corporate headquarters provided overall strategic direction to the company, allocated financial capital, coordinated operations among the subsidiaries, and managed the treasury, legal and tax functions on a company-wide basis.
The formal procedures for planning and monitoring operations were well established. At the heart of these was an annual planning process which began with the submission to corporate management of a ten-year financial projection from each subsidiary company. These projections contained a base case reflecting a continuation of the existing rate of investment and growth. Two other projections were also included, one based on a lower and the other on a higher rate of investment and growth.

The model's principal designer, a member of the corporate planning group, noted that the model had been developed to assist the corporate executive committee in appraising the plans submitted by the subsidiaries, and subsequently in deciding on the allocation of capital among the subsidiaries. Commenting on the submitted projections he said, "Although useful for the specific cases considered, some way of expanding the information was required to assess the broader aspects of corporate strategy through time. What was required was a more direct relationship between corporate management's investment decisions and the consequent financial results, capable of reflecting variations in investment emphasis at any point in time." He continued, "The model is a time-phased investment model built around individual investment decisions, and designed to explore the effects of major shifts in rates of growth."

The model created in the first instance a financial simulation of each operating division. This was based on a generalized investment module. An investment module was simply a time-phased set of cash flows, beginning with investment outlays and followed by a series of net operating cash flows. Net operating cash flow was defined as earnings before non-cash charges against revenue, interest, and tax. A module was specified by the following input parameters:
(i) size and timing of initial cash outlay.
(ii) size, timing and duration of net operating cash flows.
(iii) division of initial cash outlay among net working capital, fixed assets and expense.
(iv) depreciation rules for fixed assets.
(v) rules governing the incidence of tax payments.

Output took the form of a highly summarized income statement, cash flow statement, and balance sheet. The following measures were also included as output: the internal rate of return; the average accounting rate of return on net assets over the life of the investment; and the accounting rate of return for each year.

Building the financial model of an operating division entailed an empirical estimation of the parameters specifying the investment module. To do this, the characteristics of the typical investment project undertaken by the division were assessed. Documentation of previous investment proposals, post-completion audits of investments which had been undertaken, and managerial judgment were all used as sources of evidence in estimating the input parameters. An annual investment pattern typical of the past history of the division was constructed, and was used to create a financial simulation of the division in the following way. The model was begun by adding one set of investments in the first year of the simulation. Moving forward in simulated time to the next year, another identical set of investments was added and the net cash flows from the previous set of investments were extended into that year. This was continued through simulated time periods until the model reached a steady state. At a steady state the accounting rate of return and the amount of cash generated each year both stabilized at their mean values. The simulated steady state was then compared with the division's financial statements. Adjustments to the
financial model's input parameters were made with the purpose of achieving a reasonable identity between the output of the financial model and the division's recent financial statements.¹

The same approach was followed for each division. The corporate financial simulation was then constructed by consolidating divisions into subsidiaries and subsidiaries into corporate operations. An estimation of corporate overhead, financing, interest and dividend payments, and corporate tax payments completed the corporate financial model.

A growth rate for each division was simulated by scaling annual investment by a factor \((1+g)\), where \(g\) could take any real value, positive or negative. Thus, various rates and mixes of investment could be simulated simply by specifying an input vector of investment growth factors for the divisions.

The model was developed by the corporate planning staff using a high-level, interactive, non-procedural programming language. The model was used on an internal time-sharing service. Corporate planners were the direct users of the model, and they provided the output to the executive committee.

The model was used intensively during the annual cycle of financial planning and capital allocation. It was also used on an irregular basis whenever the executive committee was considering decisions which would affect the overall financial position and performance of the company, for instance the timing of raising new capital, changes in the dividend rate, or changes to some aspect of financial accounting policy.

A considerable ongoing effort was necessary to maintain the model's currency. For instance, changes in tax rates had to be reflected in the model's parameters and each year the corporate planning staff assessed whether the divisional simulations were still conforming reasonably closely.
to the financial statements coming from the general ledger. In addition, over the years the model was progressively developed to reflect a broadening set of applications and concerns. In the initial form of the model the simulated financial performance of a division was totally determined by its rate of investment; hence, the simulated financial performance of the corporation was determined solely by the vector of divisional growth rates specified as input to the model. In the mid-1970's the company's operating environment became much less stable than had previously been the case. The uncertainty caused by this was captured in the model by allowing variation in the margins of each division, these being specified by an additional input vector to the model. Further, during this time inflation significantly increased. The model was modified to recognize the distinction between real growth and inflation, thereby allowing its use for exploring the interaction between inflation and growth on corporate financial performance.

Comments: The model was designed to support corporate management's financial appraisal of investment strategy, an essential precursor to the detailed argument of investment plans in the organization. The kind of model typically used for this purpose is simply based on a highly summarized accounting model, and creates a projection of the future by means of a set of econometric coefficients operating on a base year. The present model is superior to this in a number of important ways. First, the model has a very precise and single-minded decision focus; indeed in its initial form the only exogenous input to the model was the vector of growth rates specifying the rate and mix of investment among the company's business units. Secondly, the model provides considerable insight to the relationships between cash flows, economic returns and accounting results, the advantages of which are convincingly enumerated by Van Breda [1981]. Next, the model
conveniently disentangles two rather different, even if related, issues in strategic planning, namely the evaluation of future steady-state positions attributable to different investment strategies and the financial trajectories through time of transitions between one strategy and another. For example, a strategy of investing more intensively in exploration might lead to a future steady state characterized by a higher real rate of return. But it would also cause an immediate reduction of reported earnings. Both considerations are likely to be considered relevant in the corporate planning argument leading to a choice of investment strategy. Finally, the model readily supports strategic contingency analysis. Both the steady states and transitional paths can be tested for their robustness to strategic shocks.

The model is a good example in practice of the approach advocated by Carleton et al [1973], except that there was never any attempt to use the model in an optimizing mode. One reason for this was simply a lack of relevant information. The model was structured in terms of constant average rates of return for each division. To use the model in an optimizing manner - say, to maximize the rate of return subject to maintaining an aggregate growth rate - would require knowledge of each division's marginal rate of return as a function of its investment rate. Such information is not readily reconstructed from most companies' financial records. Moreover, it is unlikely that divisional rates of return, either average or marginal, are independent of one another, a necessary condition to use the model correctly in an optimizing mode. ²

PLANNING AND MONITORING STRATEGIC SPENDING

The second company's model was developed in the early 1970's. The company's exploration resulted in major new oil finds in two offshore
areas. These events radically altered the company's investment pattern: there was a sudden increase in the demand for capital within the organization; and, whereas the previous pattern had consisted of a large number of relatively small projects, it was now dominated by a small number of very large projects with long lead times. Corporate management made some important strategic decisions at this point. They decided to develop the new fields, as opposed to selling their positions in them, and they decided essentially to proceed alone rather than to seek major partners. Further, they decided to maintain the same conservative debt-to-equity ratio which had been their policy in the past. Thus, even though some new equity capital was raised, the company faced a prolonged period during which the demand for capital within the organization was expected significantly to exceed the amount deemed to be available.

In these circumstances the need to modify the procedures followed for planning and controlling investment spending was widely recognized in the organization. The organization had long experience of formalized planning. The planning cycle began each year with a conference in which corporate management communicated to operating management its general goals concerning such things as earnings, growth, and the amount of investment spending. Common sets of assumptions, about such things as spot prices of crude oil, were also established at this stage. Within these general guidelines a bottom-up process proceeded, eventually leading to a three-year operating plan, a financial budget, and a capital spending program for each division. At the same time, longer-range expectations about capital spending were communicated and discussed, without these being the subject of any formal commitment.

The chief executive initially assigned to the controller's department responsibility for creating a model to support the development of investment
plans. After six months, by which time it had become apparent that the controller's department had embarked on a bottom-up general ledger type of modelling, the chief executive intervened, reassigning responsibility for the modelling development to the corporate planning group.

The corporate planning group initially spent several months formulating general criteria to guide the development of the proposed modelling system, making sure these were agreed to by top corporate and operating management. The criteria agreed upon were:

(i) the modelling system should be consistent with the planning procedures already functioning in the organization.

(ii) it should deal with cash flows, and specifically not with accrual-based accounting.

(iii) it should include only projects of strategic significance to the corporation, and specifically should not include expenditures to maintain established operations.

(iv) it should support planning and authorization of strategic investment programs, and should extend all the way through to the monitoring of spending subsequent to program implementation.

(v) it should involve no paper flow between organizational units.

The first criterion was interpreted to mean that the new system should operate in a delegated mode, and should simply apply greater formalization to the current process of communicating longer-term expectations about rates of investment spending. A ten-year planning horizon was adopted for the new system. The third criterion was eventually defined to mean any project which was expected to give rise to outlays of at least $20 million. More elaborate definitions of "strategic," dealing with such things as riskiness and magnitude of impact, were considered. It was decided that these classifying schemes were not amenable to being unequivocally communicated through the organization; hence the simpler, and more understandable, criterion of size of outlay was used.\(^3\) Included within the definition of
a strategic project was the type of investment which might entail an
immediate commitment of relatively small amounts of spending, but which
might lead to large future outlays. To illustrate, a proposal to spend
money to operate an exploratory rig in the South China Sea during the coming
year might entail less than $20 million; however, this was still defined to
be a strategic project because the exploratory drilling could generate
options which might involve subsequent outlays of considerably greater
amounts.

The system was designed to operate in a middle-up manner, starting at
the lowest organizational level at which strategic investment projects were
likely to be initiated. This was generally the level of divisional
management, but could in some instances be lower. Each organizational unit
included in the system was designated as a "Strategic Management Unit"
(SMU), with the purpose of differentiating its strategic from its operating
role.

Each SMU had its own data base in which it could store information about
all the strategic investment projects which it had under consideration. The
SMU could initiate projects as it wished, selecting from a bank of project
codes maintained centrally. The system had the following output
capabilities. It could:

(i) display the time-phased cash flows of any project in the data
    base.

(ii) display the consolidated time-phased cash flows of any
    selected set of projects.

(iii) calculate the net present value and payback period of any
    project or selected set of projects.

(iv) select the set of projects from among a larger set which would
    give the highest expected net present value, subject to
    defined constraints.

As well as entering project data an SMU could define and enter
constraints. For instance, expected spending constraints could be entered; or portfolio selection constraints - such as the selection of one project if and only if another project were selected - could be entered.

The only corporate input to an SMU's data base was the discount rate to be used in calculating net present values. This was defined at corporate level, and was the same throughout the company.

Once an SMU had constructed its preferred plan, it was transferred to the data base of the unit at the next higher level in the organization. There, it was consolidated with the plans submitted by other SMU's reporting to that unit and also with plans initiated by that unit itself. This procedure was repeated until eventually the total set of plans had been consolidated at the corporate level. In the aggregation process higher organizational levels could not discard projects originating from a lower level. In a formal sense, the managerial hierarchy was simply a conduit for consolidating strategic spending proposals emanating from throughout the organization. A considerable amount of informal communication was also taking place at the same time; however, no higher level had the right to access the data base of a lower-level unit. The confidentiality of each SMU's data base was scrupulously observed within the mode of operation of the system.

The planning group prepared a presentation for corporate executive management. This summarized the general characteristics of the proposed plans for strategic investment spending and presented them in the context of the three-year operating plans, budgets and capital spending programs which had already been prepared through the operating planning and control system. Usually, the proposed spending substantially exceeded the amount which corporate management was willing to authorize. The principal constraint in this respect was the amount of spending which would be
expensed, with its attendant effect on the expected level of reported earnings in the first three years of the corporate plan. This review, along with established strategic priorities, gave corporate management the basis for providing definitive feedback concerning the amount and nature of reductions they were seeking in the proposed strategic investment spending. Several iterations through the process were usually required before a set of strategic spending plans were established which were agreeable to all levels of management.

Subsequent strategic spending was accumulated and reported by project and by SMU. The strategic spending system became, in effect, a subsidiary ledger in the accounting system. For accounting purposes the accumulated spending in the system was periodically analyzed and distributed to the general ledger by a summary set of entries.5

The system was used regularly to review progress on strategic spending, and to update spending plans. A full re-planning and re-authorization of strategic spending was undertaken on at least a bi-annual basis. However, any major event, or significant shift in business conditions, could trigger a thorough review of the rate and mix of authorized strategic spending, either for the company in its entirety or for business areas within the company.

The modelling system was developed by two members of the corporate planning group. There was no formal budget for the effort, no steering committee, and no special project team. It was, in effect, simply regarded as an evolutionary development of the formal managerial support systems in the organization. The planning staff essentially replicated in a formal modelling system aspects of the existing methods for identifying and analyzing strategic spending, making the support of the activity, and the communication within the organization, more effective. The first working
system was in place within two years of starting the modelling effort. It was programmed by the corporate planners using BASIC, and was subsequently re-programmed by the data processing staff in FORTRAN to increase its efficiency. However, the re-programming was done in such a way as not to compromise the system's features from a user standpoint.

The initial system only dealt with financial data. Hence, verbal description had to be maintained in manual files and communicated by written documents cross-referenced to the financial data by means of the project codes. The chief executive was adamant about eliminating all paper flow; therefore the system was modified to handle verbal statements about projects, including such things as the purpose of a project, key input assumptions, and major sources of risk which might affect the successful realization of the project.

Comments: A striking aspect of the design of the modelling system is the care with which it was integrated into the managerial process. The principal design focus was the organizational structure, and the planning process already in place. The underlying logic and data processing of the system are relatively mundane; they are nonetheless constructive in supporting the communication and managerial decision making which are central to strategic planning.

Planning investment strategy requires an effective integration between a firm-wide perspective and the knowledge of opportunities and prevailing circumstances at the local level. It is commonly supposed that this should be achieved by centralizing authority for project selection; hence, project information has to be communicated from the local to the corporate level. In this case the rate and mix of spending decision was centralized, but project selection was delegated. Two principal reasons were given for this. In the first place, it was considered more efficient to communicate
downwards the relatively small number of salient considerations which prevailed at the corporate level than to communicate upwards all the myriad details and nuances of judgement which go into selecting a set of strategic investment projects. And secondly, it was believed that a greater psychological commitment to seeking out, analyzing and implementing investment opportunities would be sustained by delegating the project decision.

The modelling system makes a very transparent connection between choices of investment strategy and their financial consequences in cash-flow and net present value terms. It therefore escapes from the artificial distinction between capital assets and expenses which, in the name of conservatism, the accounting model imposes on expenditures. There is no reason, for example, to regard expenditures on exploration as any less of an investment than expenditures on machinery just because the former are expensed and the latter capitalized in the accounts. Any expenditure which enhances the firm's growth options and future profitability should be considered on an equal footing in the planning phase. The system allows this to happen. In addition, this equal footing is extended all the way through to monitoring and accountability by holding the reporting of strategic expenditures apart from the general ledger.

SUMMARY AND CONCLUSIONS

The two models considered in the paper are complementary to one another. Indeed, the use of both within one organization could readily be visualized, in much the way that Lorange and Rockart [1977] prescribe. The first model supports corporate management's financial appraisal of investment strategy. The key features of the modelling support of this phase of the decision process are the abilities to: (1) explore the
structural properties of the steady-state positions of existing and alternative investment strategies; (2) trace out financial trajectories between one strategy and another; and (3) explore the financial consequences of strategic contingencies. The next phase, supported by the second model, entails a detailed argument of investment plans throughout the organization. It has as its aim arriving at a coordinated plan which simultaneously conforms to corporate strategic guidelines and maximizes business prospects when viewed in a delegated perspective. The key features of the modelling support of this phase are: (1) the transparency of the connection between strategies and their financial consequences; and (2), in a similar vein, sustaining a clear connection between strategic planning, resource allocation, monitoring, and managerial accountability for strategic progress.

In both the cases the pitfalls enumerated by Hall [1973], referred to earlier in the paper, were avoided. An important reason for this was that the planners were themselves responsible for developing and implementing the models, an approach which is becoming ever more feasible with the emergence of fourth-generation programming languages. Another reason was that in both companies there existed clear managerial roles and prerogatives, well-estabished planning and control processes, and clear definitions of line and staff relationships in the organization. The literature of DSS emphasizes the need to align the logic of a system to the cognitive process of the user. When a system is intended for widespread use in an organization it has to build on a common base of understanding shared by a large number and variety of potential users. In these circumstances, the analogue of cognitive process is organizationzal context and process, and these assume great significance as an intellectual focus for the design effort. Furthermore, such things as commonly-accepted definitions of terms
assume just as great importance as the conceptual and analytical rigor of the system as judged from a normative, decision-science perspective.

Both models include an economic analysis to aid in assessing the desirability of strategies and projects. But in neither case was there any attempt to impost a strict economic optimization on the resource allocation process. In the second case, for instance, it was perfectly acceptable to include projects in a proposed strategic investment program for which no estimate of future cash inflows had been made on the grounds that these were so uncertain as not to be meaningful. As pointed out by Myers [1984], much of an organization's strategic investment is akin to entering into an option contract. Accordingly, the application of standard discounted cash flow techniques to the entrepreneurial and speculative component of strategic investment would result in undervaluing the investment.

In both cases the accounting framework is, in a sense, pushed into the background. To the extent that accounting logic is arcane to most line managers this is probably all to the good. And yet the accounting framework has an influential role in the corporate investment strategy decision in both cases. As proposed by Lerner and Rappaport [1968], and refined subsequently by Dyckman and Kinard [1973], the principal constraints on the rate and mix of investment are defined by reference to the effect they are expected to have on the pattern of reported net income and earnings per share.

Finally, both models are remarkable for the single-mindedness of their focus on the decision processes they are intended to support. They reduce unnecessary complexity, filter out stochastic disturbances which might divert attention from the matter at hand, and they create transparent connections between the parameters under management's control and the financial outcomes of decisions. They add no embellishments which might
either contribute to the psychic satisfaction of the modellers or prove useful in the future should the application of the model expand to cover more areas of decision making. It would be wrong however to describe the models as "simple;" they are simply dedicated to their defined purposes. Their sophistication has to be viewed in conjunction with the managerial processes in which they are embedded. The models enhance the data handling and calculational capabilities of the process. Management is left to argue through and interpret the uncertainty in the external environment, and their individual and collective preferences for feasible outcomes in arriving at decisions. This division of duties between the modelling systems and the managerial organization appears to be efficient from both a data-availability and modelling perspective and from a political perspective of the resource-allocation process.
Footnotes

1. At first sight this appear to be an attempt to validate the financial simulation model. Of course, it is not a validation in any strict sense. The step seems explainable largely in terms of building confidence in the model among its direct and indirect users.

2. Of course, this is a source of error even when the model is used in a descriptive mode as described in the case study. It would be a concern if radically different mixes of investment from past experience were being contemplated.

3. The $20 million was decided upon by estimating how many projects would be included in the strategic system, and the proportion of investment falling into the strategic and operating budgeting systems respectively. It is interesting to note the "ad-hoc" nature of the operational definition of terms such as "strategic;" much of the planning literature appears to suppose that these words have some precise meaning.

4. Consistent with the philosophy of delegation, the only reason for handling a strategic investment project at a higher level of the organization would be if it required coordination across two or more lower-level SMU's.

5. The strategic spending account was in principle akin to a capital work-in-progress account, which is commonly used in corporate accounting systems.

6. For a more comprehensive and complete argument of this point the reader is referred to Vancil [1972].
References


